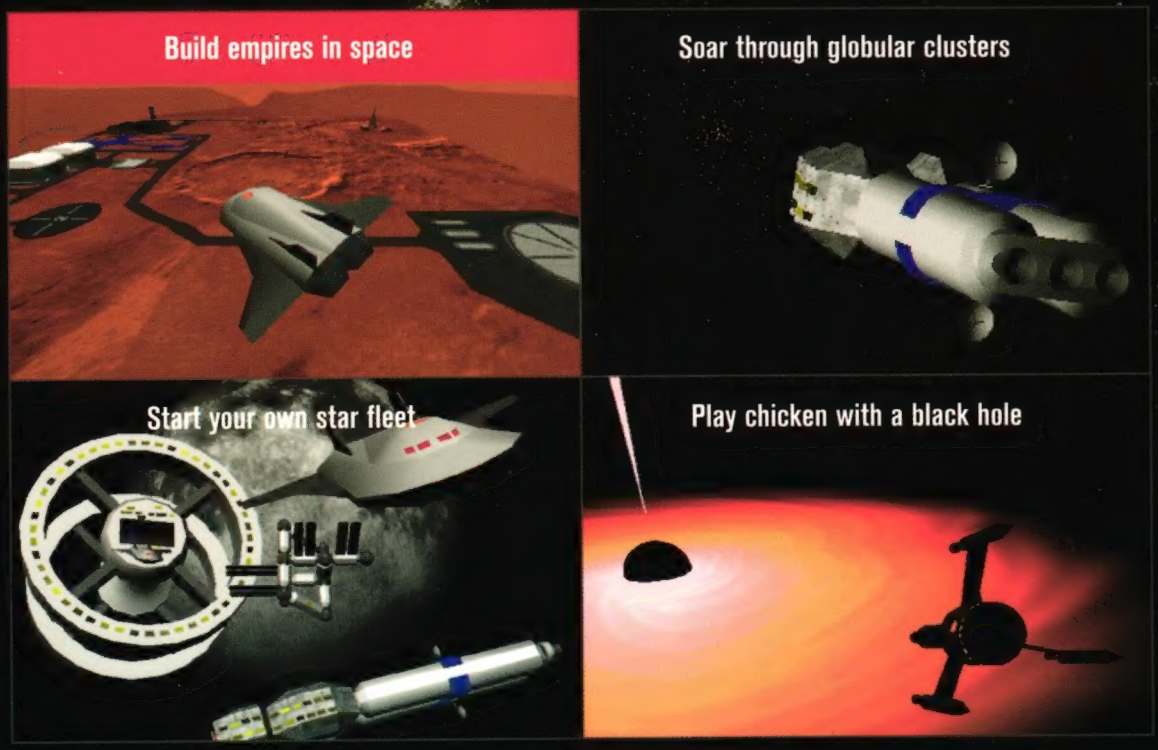
THE ULTIMATE DESKTOP ASTRONAUT'S GUIDE

ADVENTURES IN Space Simulator

IN BREATHTAKING FULL COLOR



Microsoft Press

Grant Fjermedal

Adventures in
SPACE SIMULATOR

The Ultimate Desktop Astronaut's Guide

Grant Fjermedal



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For Cyrus Pappenheimer
1977 to 1990
A brave boy who journeyed early to the other side



Contents

Acknowledgments ix

Chapter 1

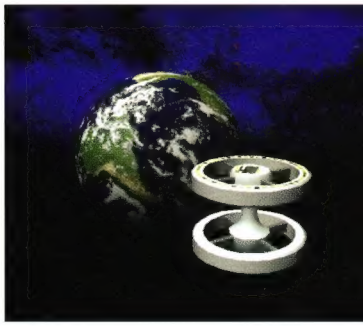
The Journey Begins 1
MISSION: We're Out of Here! 3
MISSION: Spacewalking 5
MISSION: Back to the Garden 7
MISSION: A Return to Orbit 10

Chapter 2

Driving Without Your License 12
How Do We Make This Thing Go? 13
Flying with the Keyboard 15
MISSION: Chasing Down Ring Station 1 19
MISSION: Danger! Running the Rings 20
Flying with the Mouse 22
Flying with the Joystick 24

Chapter 3

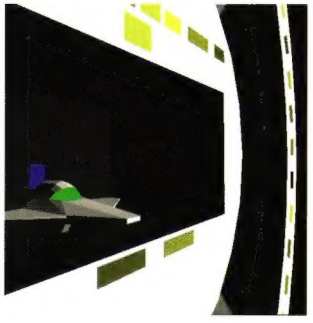
Cruising Through Space 27
Undoing Gravity and Nullifying Newton 28
MISSION: A Scientific Inquiry into the Excellence of Slew Control 31
MISSION: Spinning Out with Newtonian Physics 32
Looking Good with Slew Control 33
MISSION: Using Time as Your Throttle 40













Chapter 4

The Joy of Just Looking Around 46

Looking Out Your Cockpit Window 47
Seeing the Sights with the Panning Bars 48
MISSION: Walking Around the Cockpit 50
The Power of Zoom 51
Fun with the Location Button 54
MISSION: Cycling Between Views While Orbiting Callisto 57
MISSION: Close Maneuvers at the Mars Orbiter 59
The Direction Button: Panning and Tracking 61
MISSION: Tracking Earth on a Flyby 62
Taking a Closer Look at the Window Menu 63

Chapter 5

Piloting with Precision 73

The Beauty Is in the Control 74
Using the Fine Thrust Gauge 75
MISSION: Docking with Ring Station 1 79
Flying the MMU with Fine Thrust 83
MISSION: Flying the MMU to Ring Station 1 83
Using Fine Thrust in Slew Control 85
MISSION: Exploring the Cargo Bay 89
MISSION: A "Home Movie" of the MMU 91

Chapter 6

Tweaking Your Preferences 93

Opening the Preferences Dialog Box 94
Precision Preferences 94
Scenery Preferences 96
Rendering Preferences 98
Label Preferences 101
Keyboard Preferences 104
Skill Level Preferences 106
Sound Preferences 106

Chapter 7

Great Locations 107

A Closer Look at the Location Menu 108
MISSION: Flying Between the Martian Moons 112
MISSION: A Journey from Andromeda to Earth 116
Exploring New Solar Systems 119
MISSION: Visiting the Planets of Polaris 120
Using the Set Location Command 123
MISSION: Mining the Asteroids 126

Chapter 8

Saving Yourself with Situations 129

Saving the Situation 131
The Open Situation Dialog Box 132
The Save Situation Dialog Box 134
Creating Outstanding Situations 136
Creating a Very Busy Sky 147
MISSION: Building Your Own Playground 149

Chapter 9

Using the Autopilot and the Flight Computer 152

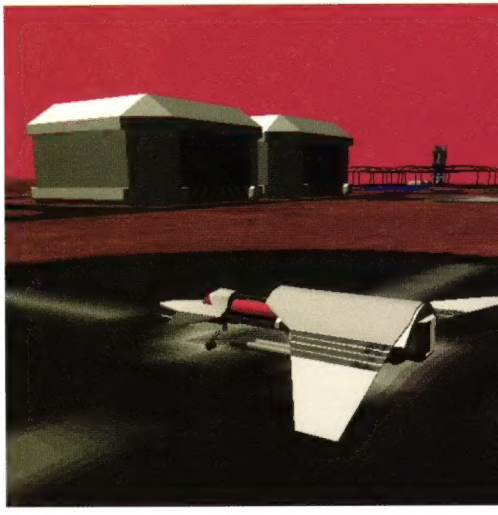
The Autopilot: No Ship Should Be Without One 153
The Flight Computer: Your Robotic Copilot 161
MISSION: A Quick Trip Around Our Solar System 163
MISSION: Flying a Space Station to the Stars 167

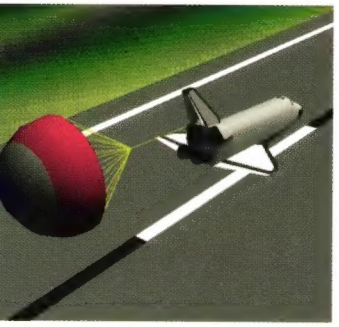
Chapter 10

Exploring with the Camera and the Video Recorder 171

Using the Camera 174
Taking Great Space Photos 175
Displaying Your Photos in Microsoft Windows 182
Making Movies with the Video Recorder 183
MISSION: The Mars Movie 189









Chapter 11

Flying Like a Starship Master 197

Fun with Atmospheric Entries 201
Orbital Mechanics for the Starship Master 207
Using the Observatory 209
MISSION: Watching Mars from Phobos 209
Diving into Some Daring Missions 216
"Start the Timer" Missions 216
MISSION: Threading the Needle 216
MISSION: In from the Cold 218
MISSION: Parking Test 218
MISSION: Saturn Giant Slalom 220
"Daring But Dangerous" Missions 221
MISSION: Riding the Wild Horses of Space 221
MISSION: Playing Chicken with the Black Hole 223
"Empire Building" Missions 224
MISSION: Colonizing Space 224
MISSION: Creating Your Own Getaway (and Gas Station) 226
"For the Curious" Missions 228
MISSION: Charting the Globular Clusters 228
MISSION: In the Steps of Voyager 2 229
MISSION: The Visions of Ptolemy 230
The Never-Ending Mission: Explore, Have Fun, and Don't Forget to Write! 232

Index 233

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The Bruce Artwick Organization fielded an awesome team to bring Space Simulator into existence. At the helm, steering the effort into space, was Charles Guy, who conceived of and designed this wonderful passageway into the stars. (Charles was also generous with his time in allowing me to interview him throughout the development process and letting me use quotations from our interviews throughout this book.) Joining Charles in the development effort were Phil Parker, Chris Alix, Tony Zander, David Librik, Greg Seehusen, Mark Randel, Dave Denhart, and Xiaodong Tan. (For a listing of who did what, choose About Space from the Help menu, and then choose the Credits button.)

Lynn Guthrie was the brilliant editor of the way-cool *Star-Pilot's Guide* (which gets tucked into every box of Space Simulator) and was kind enough to do a much-appreciated technical read of the book you now hold in your hands. She was a major contributor throughout the creation of Space Simulator and a constant inspiration.

Finally, I'd like to thank Space Simulator's great program manager, Jon Solon, the very special dynamo who, after managing Flight Simulator through several iterations (including the super-sweet version 4.0 release for the Macintosh), tracked down rumors that BAO was turning its eyes toward the stars and helped to boost the project into orbit. Space Simulator was created at a time when much of the computer world was heading toward Microsoft Windows, but when the raw horsepower of MS-DOS was still required to maximize the smoothness of the simulation. I used to kid Jon about "putting lipstick and rouge on the elderly Madame DOS," but his dedication to creating a Windows-like interface is why Space Simulator is so easy and pleasant to move around in. Throughout Space Simulator are the loving (and exhaustive) touches of Jon Solon.

Now that Charles and Jon and their teams at BAO and Microsoft have created this stairway to the heavens, this personal gateway into the galaxy, I hope that people around the globe will accept the opportunity to leave Earth and travel and explore throughout the great realm of space.



1

THE JOURNEY BEGINS

Floating thousands of kilometers above Earth, I have glided along the blue expanse of solar panels as if I were an angel cruising the streets of heaven.

Aboard a starship freighter, I have taken great journeys beyond our solar system.

Piloting my own interstellar craft, I have traveled so incredibly far from home that all of the Milky Way could be seen, small and shining below, as the spiraling galaxy that it truly is.

I have danced with the moons of Jupiter and explored the planets of distant stars.

On my wilder days I have purloined space stations and moved them to new orbits, building a secret community unlike anything one could find on Earth. And, just to keep the tension high, I've skipped my ship off atmospheres like a smooth stone against the water, ventured too near the fusion heat of young stars, and dared to play chicken with a black hole that resides ominously at the very heart of the galaxy.

For two years I've roamed through the world of Space Simulator. Now I've come back to Earth just long enough to share this secret with you: "I've found a way off this planet!"

You've just gotten your own copy of Space Simulator, and it's time to blast off. Unimaginable vastness awaits on the other side. The escape from Earth is so complete that a sense of conspiracy fills the air.

You're about to launch into a world where—officially—you don't yet belong. For decades to come, only government-approved astronauts, cosmonauts, and such will be allowed to travel their wee distances into space. (Traveling up to shuttle orbit would be only minutes away by elevator—if we could get the shaft built, decide on the carpeting, and find just the right elevator music.)

But you're about to make an end run around all the official barriers to space travel. Besides, it's more fun this way. Because you aren't *supposed* to be up in space for years to come, this makes you something of a pirate—not the mean kind, just the romantic kind, the kind who doesn't want to remain tied to the dock when all the oceans of the world are calling, the kind who doesn't want to remain bound to Earth when all the galaxy is calling. Steve Jobs, a cofounder of Apple Computer, used to inspire the team that was creating the Macintosh by saying, "It's more fun to be a pirate than to be in the navy." In this case, NASA is definitely the navy.

In truth, of course, NASA has been a heroic pioneer. Space is a hostile environment for humans, and every one of those men and women who have strapped into a rocket to venture into space is braver than I could ever hope to be. It's also true that it costs a lot of money to boost a spaceship out of Earth's gravity. So, rather than wait the many decades it might take to reach the economies of scale that will allow *you* and *me* to get into space, it makes more sense to try our escape now. And when you start up Space Simulator, that's just what you get to do!

MISSION: We're Out of Here!

Once you start Space Simulator, you're in space. That computer screen of yours is just the windshield of your spacecraft. Your keyboard, mouse, and joystick are your controls.

There are all kinds of basics I really should tell you about before taking you out flying, but . . . just for the fun of it, let's slip out of Earth orbit and take a quick, unofficial tour of what awaits you.

Saturn, for example, is a stunning jewel of a planet, with its thin rings of floating ice chunks and the moons that are always dancing around it. Because we haven't talked about flight controls yet, we'll travel by way of the Options menu, which can transport our spacecraft across the solar system faster than if we were popping into some sort of hyperspace. The simple procedures are outlined here.

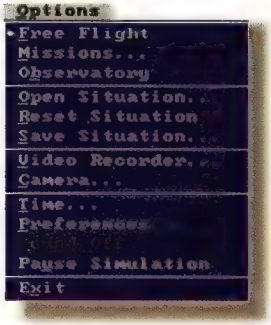


TECH TIP

In Space Simulator, you can "choose" or "select" an item either with a click of the left mouse button or with the keyboard. You can open a menu, choose a command, or adjust settings and selections in a dialog box as described in this set of instructions.

Blasting Over to Saturn

1. From the menu bar, open the Options menu. To do this, you can either move the mouse pointer to the menu bar and then click the menu name with your left mouse button or press the Alt key to activate the menu bar and then press O (the underlined letter in the menu name).
2. Choose the Open Situation command from the Options menu by clicking the command name with the left mouse button or by pressing O (the underlined letter in the command name).
3. When the Open Situation dialog box appears, scroll through the list box of filenames until you locate the name MOONDANZ. To scroll through a list, use the up and down arrow keys or click the up and down arrows to the right of the list box. Select (highlight) MOONDANZ by either clicking the filename or using the arrow keys to move the highlight to the name.
4. Read the Description box, which tells you what you'll be seeing.
5. Choose OK by clicking the OK button or pressing Enter.





Your ship is now about 200,000 kilometers from Saturn, nicely placed to take in the view of this ringed beauty and its moons. The lower half of your screen shows your ship's map display of the labeled moons in their orbits. (If 200,000 kilometers seems like a long way, which it certainly is, consider that you are now nearly 1.5 *billion* kilometers from Earth.)



TECH TIP

In Space Simulator, the minus sign (–) key on the main keyboard and the minus sign (–) key on the numeric keypad have different functions. The same is true for the plus sign (+) keys. When you see an instruction such as "Press the minus sign key 16 times," you should press the key on the main keyboard. If you need to use a key on the numeric keypad instead, the instructions will specify this: "Press the keypad plus sign key." (And don't worry, the spacecraft won't explode if you press the wrong key.)

Let's try a few experiments to see some of the awesome power you'll have each time you climb aboard your spacecraft and leave Earth:

- To better see the orbits of Saturn's moons, press 1 on the main keyboard. Then press the minus sign (–) key on the main keyboard 16 times. This pulls back your view of Saturn so that the orbits of the most distant moons are visible. This is a sight I've sat and watched for embarrassing lengths of time. No need for embarrassment, though, as the orbital dance of Saturn's moons serves as a model for so much of what we know, and imagine, about the greater universe. It's a dance of gravity and matter, made visible to our eyes through the presence of light.
- To speed the orbital dance, press F1 again and again. Each keypress doubles the speed at which time passes.
- To slow the orbital dance, press F2 again and again. Each keypress halves the speed at which time passes.

Find the orbital speed you like, and then notice how the inner moons orbit at a greater velocity than the outer moons. There's great natural (and mathematical) beauty to be found within Space Simulator. (I'm doing it again, just staring at the moons gliding around Saturn. It's nearly midnight, some nice piano music is playing on the stereo, and I'm getting drawn into the beauty of the orbits: these miniature worlds circling the mystery of Saturn, all against the backdrop of the great beyond.)



Later you'll learn how to fly up close to a planet, rendezvous with its moons, and land. You'll even learn how to travel to unexplored stellar systems and search for undiscovered planets. But for now our quick trip continues.

MISSION: Spacewalking

You'll find some awesome space stations out there. A great way to see them and to appreciate their massive size is by going out for a space walk in a manned maneuvering unit, or MMU. Let's take a space walk along the massive structure of Ring Station 1.



Spacewalking Outside Ring Station 1

1. From the menu bar, open the Options menu.
2. Choose the Open Situation command from the Options menu.
3. In the Open Situation dialog box, scroll through the list of filenames and select MMU1.
4. Choose OK.

The first astronauts to spacewalk must have been nearly delirious with the beauty of what they saw. There they were, swimming in space, one whole world before them, and unimaginable worlds beyond. No wonder they were on a tether—someone probably had to reel them back in to keep them from running off into space! Now here you are, floating a kilometer from this vast ring station, and without a tether.

The first time I created a version of this situation, a friend started rummaging through his compact discs and pulled out Gustav Holst's *The Planets*. He had me restart the situation just as he cued up the first movement, *Mars, the Bringer of War*. Trying to match music to the situations you create in Space Simulator can be fascinating. I've found that Mahler is ferociously appropriate for space, to the point where you wonder whether perhaps he'd already seen all of it before. And I've always thought that some of the music from the 1960s would go well with any number of Space Simulator's situations—Pink Floyd's album *Dark Side of the Moon*, for example, or Jimi Hendrix's *Electric Ladyland*.

"[Going on a space walk] changes your perspective. That is really the great outdoors. You feel as though you are a satellite yourself. It really makes the heart go. You understand that it is you and the universe, and you really feel like an individual."

—Edward G. Gibson,
American astronaut

"No one regards what is before his feet; we all gaze at the stars."

Quintus Ennius
Roman poet
239–169 B.C.

BEHIND THE SCENES

Flying Astronomy with the Greatest of Space Simulators

That night back in June of 1992 was just a little magical. I was perched on a hilltop overlooking Lake Chelan with Jon Solon, Microsoft's program manager for Space Simulator, and Charles Guy, the programming genius behind Space Simulator, who was visiting from the Bruce Artwick Organization (BAO) of Champaign, Illinois.

Earlier in the day, Jon and I had packed my telescope—a Coulter Odyssey Compact with a 10-inch mirror—into the back of Jon's Toyota 4-Runner and driven to the airport to pick up Charles. Then we headed east across the Cascade Mountains for the four-hour trip to the house Jon was building on a hillside lookout.

The long sun of the northern sky was just giving way to night when we arrived, and we wasted no time in unloading the telescope and setting it up in the middle of Jon's road. We overturned an old plastic bucket from the construction site and used it as a stool.

"I'll tell you where I'm headed," Charles said, as he took hold of the telescope tube. "I'm headed to Sagittarius. I'll often go to M22, then M8, M17. I like to go south to north, hitting all the H2 regions, and the good globulars and open clusters. There are a lot of them in Sagittarius."

But first Charles guided the scope up to the constellation Cygnus to look at the Veil nebula. He seems to have a special liking for the vast clouds of hydrogen that arch across the sky, giving of themselves to create new stars. As we looked at the Veil, Charles spoke of another hydrogen cloud, one that is 30 light-years across and could encompass 20,000 of our solar systems placed end to end. He spoke of that cloud, which wouldn't return to the night sky until fall, as if it were an old friend: "I never tire of looking at Orion."

We stood out there past midnight. Looking at M13, the great globular cluster in Hercules, that wondrous ball of one million stars, Charles called Jon over to the 9-mm Televue eyepiece and exclaimed, "This is spectacular! We can resolve individual stars along the edge."

And then he said, "Can you believe that we're going to try to put all of this inside a computer?"

MISSION: Back to the Garden

Several years ago I wrote a book called *The Tomorrow Makers*. Toward the end of the book, I described a party I attended at nanotechnology guru Eric Drexler's place in Cambridge (during his L5 and MIT days) where everyone there expressed a great deal of passion about getting off the planet. Very late that night, a guitar came out, songs were sung, and someone ventured that the most beautiful poetry in praise of Earth was yet to be written and that it would come only when space explorers had seen enough of other worlds to more completely realize what a special treasure garden of a planet we have.

"I had some idea of the huge variety of color and land masses and cloud cover which I would see from 100 miles up. But no one could be briefed well enough to be completely prepared for the astonishing view that I got."

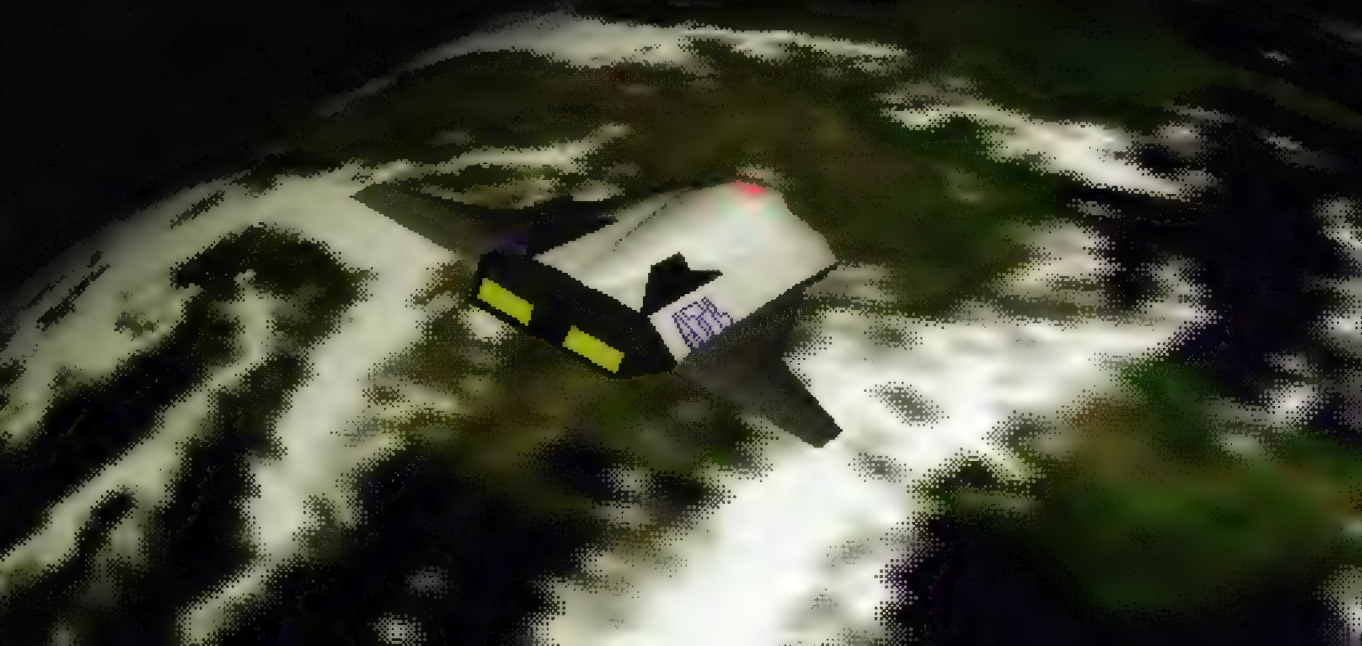
—Alan B. Shepard, Jr.
American astronaut

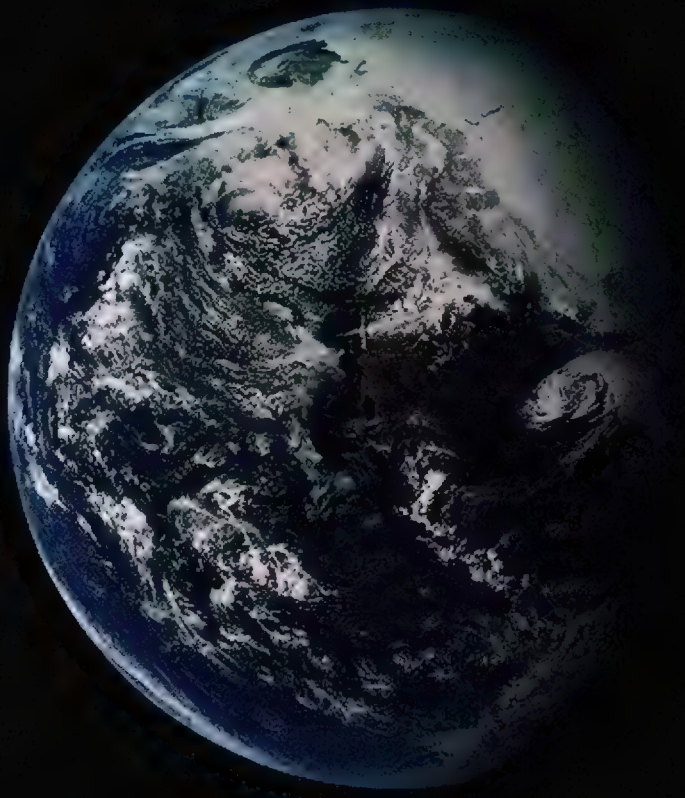
Let's take a look at the Big Blue Marble as it's seen during reentry. We'll join the flight in progress by opening a situation.

Going Back to the Garden

1. From the menu bar, open the Options menu.
2. Choose the Open Situation command from the Options menu.
3. In the Open Situation dialog box, scroll through the list of filenames and select COASTAL.
4. Choose OK.

As the situation opens, you are a little more than 4,000 kilometers above the surface of the planet, cranking along at 27 kilometers per second. (That's about 60,400 miles per hour.) All of North America lies just ahead. Central America separates the Pacific Ocean from the Atlantic. From this height, it looks as if you would need half a continent to land.





ASTRONOMICALLY SPEAKING
Behold the Earth!

Whenever you start Space Simulator, you might enjoy taking a few minutes to just watch Earth as it sits against the black velvet backdrop of space. The blue of its oceans and the white of its clouds swirl together, making it look like a jewel. Many people contend that the most valuable prizes humans brought back from space were not the moon rocks, not the experiments, but simply the photographs of our planet as this painfully beautiful garden world sitting by itself out in space.

This sweet and gentle planet had its birth within the violent, chaotic, and fiery time of our early solar system, when molten material gravitationally condensed into the lumps of firmament that we now call planets. Though it is but one of nine planets in our solar system, Earth seems to have been in the right place at the right time and was blessed with oceans, land, and a life-sustaining atmosphere. It has a diameter of 12,752 kilometers (or 7,926 miles) and is 149,471,000 kilometers (92,897,000 miles) away from the Sun. Earth spins on its axis once every 23 hours and 56 minutes, giving us day and night. It revolves around the Sun in an orbit that takes slightly more than 365 days, which (combined with its orbital tilt) provides us with seasons. It speeds along on its orbit at about 30 kilometers per second (67,109 miles per hour), proceeding silently through the great stillness of space.





TECH TIP

Space Simulator uses kilometers instead of miles in measuring distances. If you're accustomed to thinking in terms of miles, you can multiply the number of kilometers by 0.62 to convert to miles, or you can simply figure that the number in miles is about 40 percent lower.



MISSION: A Return to Orbit

You might enjoy taking some time now to open still more of Space Simulator's situations, just to see what is out there waiting for you. (Use the Open Situation command on the Options menu as you've done throughout the chapter.) After you've cruised through enough situations, it'll be time to get back to our initial Earth orbit, the orbit we were in before deciding to sneak away for a quick tour.

The real fun will begin in the following chapters as you learn more and more about the instrument panel and the flight controls and about how you can make the entire realm of Space Simulator your own domain. But you'll want to be careful not to



get completely lost in space—which is to say that every now and then you'll want to return to Earth-based reality long enough to be sure that your more mundane concerns are still on track.

Returning to the Opening Earth Orbit

1. From the menu bar, open the Options menu.
2. Choose the Open Situation command from the Options menu.
3. In the Open Situation dialog box, scroll through the list of filenames and select FLIGHT.
4. Choose OK.



2

DRIVING WITHOUT YOUR LICENSE

Now that we've spent our first chapter joyriding around the solar system, the thought occurs that we should probably get more serious and move into kind of a flight-school phase where we really crack the books on the basics. After all, astronauts must wade through immense stacks of three-ring-bindered documentation before they are allowed to even sit inside a spacecraft. But, on second thought, that doesn't really sound like much fun, does it?

So let's just continue to fly these great ships around, learning as we travel through space. I'm reminded of the one Thanksgiving dinner I ever cooked, for my younger brother and his two preteen sons. Since I'd never cooked a turkey before (and because I can hardly boil an egg), I planned to de-emphasize the traditional aspects of the dinner. As soon as the kids arrived, I gave them each an ice cream cone. For the second course, we each had our own pumpkin pie, and we shared a gallon of vanilla ice cream. Later, as it turned out, the turkey was good, too. At the end of the feast, instead of asking ourselves whether we still had room for dessert, we were asking ourselves whether we still had room for beets.

The structure of that meal has appealed to me ever since. So, in the tradition of having pie and ice cream first, let's once again blast into space. This time, we'll get a little driving practice as we travel.

How Do We Make This Thing Go?

Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK. This brings us back to Space Simulator's home base, with its view of Earth and the outpost Ring Station 1. Without further ado, let's rattle the engine room by applying some thrust.

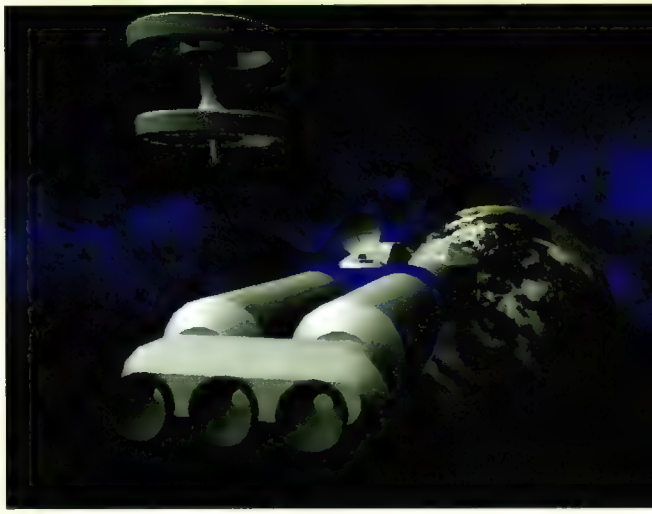


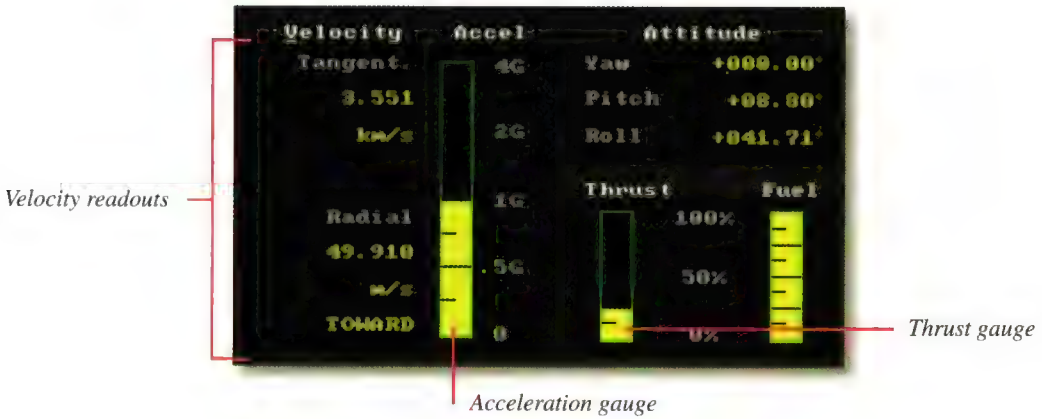
TECH TIP

Pressing the F7 key increases thrust, just as pressing keypad plus sign does. And pressing F6 decreases thrust.

Applying Thrust

1. Press the keypad plus sign key once. On the instrument panel, you'll see a thin yellow line appear at the bottom of the thrust gauge. The acceleration gauge also begins to fill in with yellow. (See the illustration on page 14.)
2. Press the keypad plus sign key four more times. Watch the thrust and acceleration gauges climb with each keypress.
3. Continue pressing keypad plus sign until the acceleration gauge shows a readout of 1 G, which refers to 1 gravity of thrust. Notice that both the tangential and radial velocity readouts increase. The radial readout, which indicates your velocity moving either toward or away from the reference object (Earth, in this case), increases more rapidly than the tangential readout, which shows "sideways," or orbital, motion in relation to the reference object.
4. Press keypad plus sign repeatedly until the acceleration gauge maxes out at 4 Gs. The thrust gauge also maxes out, and the radial velocity readout continues to increase.





Reducing Thrust

1. Press the keypad minus sign key. Each keypress reduces the thrust incrementally.
2. Press the keypad minus sign key several times until the reading on the acceleration gauge is reduced from 4 Gs to 2 Gs. The thrust gauge also displays a corresponding reduction with each keypress.
3. Press keypad minus sign repeatedly until the readings on the acceleration and thrust gauges are reduced to 0. Notice, however, that your velocity is not reduced.

According to the Newtonian mechanics of spaceflight, within the vacuum of space an object will continue at its current velocity until it is acted upon by another force. This means that if you throw a softball out your spaceship's window, that ball will continue traveling through space for billions of years (forever, actually) without losing any of its speed. (For more information on Newtonian mechanics and a discussion of the relationship between thrust, acceleration, and velocity, see "Looking Good with Slew Control," in Chapter 3.)

BEHIND THE SCENES
When Do We Give Them the Car Keys?

When Space Simulator's user manual, the Star-Pilot's Guide, *was in its planning stages, the order of instruction was a much-debated topic. At the top of the list was the issue of how much users ought to be told before they are shown how to fly a spacecraft. The fear was that once they were up and flying, they wouldn't continue reading and hence would not benefit from knowing about all the other cool things they could do. The writer summed up the concern this way: "At what point do we give them the car keys—and once we do, will we ever see them again?"*

Flying with the Keyboard

Now that you know how to use the gas pedal, you should find out where the steering wheel is. (I wonder if many driver training classes on Earth progress in this order?)

You can steer the spacecraft using the keyboard, the mouse, or a joystick. As you'll see, the joystick is by far the easiest method and the most fun, but you can also fly quite nicely with keyboard controls.

If you're still running the FLIGHT situation in which you experimented with applying thrust, you are heading straight for Earth and have already blown past Ring Station 1. (If Earth hasn't started to seem larger yet, don't worry—it will.) Let's create a zigzagging pathway toward the planet by steering with the rotation controls.



TECH TIP

The F3 key works just like keypad 5 to stop rotation. Keypad 5 is handy when you're flying with keypad controls. But if you're flying with a joystick (and especially if you're right-handed), you might find F3 more convenient.

Zigzagging Toward Earth

1. Press the left arrow key. As your spacecraft turns toward the left, Earth begins to drift to the right of your cockpit window.
2. Press the keypad 5 key. Keypad 5 stops all rotation. You'll use this key constantly throughout your travels.
3. Press the right arrow key. As your spacecraft begins to turn right, Earth begins to move toward the center of your cockpit window.
4. When Earth is centered in front of you, press keypad 5 to stop rotation.

Turning up or down is as easy as turning left or right: Simply use the up or down arrow key. If you haven't yet blasted past Earth, try using all four arrow keys now, playing around with these rotation controls. Be sure to keep Earth in view, pressing keypad 5 to stop your rotation if you start to lose sight of the planet.

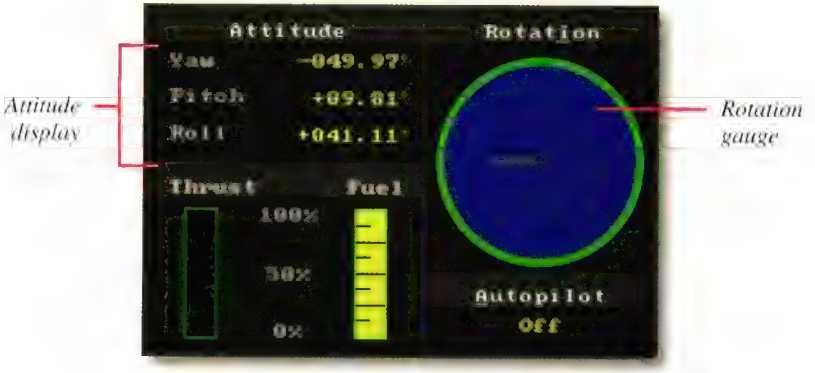
In addition to rotating your spacecraft with these two methods, you can also have your ship do a roll. To use any of these rotations—known as *yaw*, *pitch*, and *roll*—for precise maneuvering, you'll want to keep an eye on the rotation gauge and the attitude display.

Rotation Gauge and Attitude Display

Located on the instrument panel, the rotation gauge and the attitude display let you see what is happening as you steer your spacecraft. The *rotation gauge* is a visual reference indicating the direction in which your ship is rotating. For example, as you press the left arrow key to turn the ship left, a yellow line reaches out from the

center of the gauge, extending toward the left. The farther the yellow line extends from the center, the faster you are rotating.

The *attitude display*, just beside the rotation gauge, provides an exact readout of how many degrees you have rotated away from your reference object in terms of yaw, pitch, and roll.





TECH TIP

Centered below your cockpit window is the Location button, which indicates your current view: Cockpit, Chase, or Assigned. In Cockpit view, you are looking out your cockpit window. If you then click the button or press the S key, your view (your "viewing location") shifts; you'll suddenly see your ship from an outside vantage point, as it would be viewed by a chase craft. As you practice rotations, set the Location button to Chase for a nice view of your piloting skills in action. To cycle back to Cockpit view, choose the button twice more. (For more information on views, see Chapter 4.)

Yaw

Whether you're flying an airplane across a field on Earth or flying a huge interstellar starship, the correct term to describe turning left or right is *yawing*. We should use the correct terms now that we're in space, so from now on we will speak of *yaw left* and *yaw right*.

Let's try to do a complete rotation of the spacecraft by yawing. To return to familiar territory, with a view of Earth and Ring Station 1, choose the Open Situation command from the Options menu, select FLIGHT in the dialog box, and choose OK.

Yawing Left 360 Degrees

1. Press the left arrow key 12 times. Notice how the rotation gauge and the attitude display respond to each keypress. The farther the yellow line extends from the center of the gauge, the more rotation you are applying to your spacecraft; when the yellow line reaches the outer edge of the rotation gauge, you have applied full rotation thrust. The attitude display's yaw readout registers a minus number when you are yawing left of the reference object (which is Earth, in this case) and a positive number when you are yawing to the right.
2. As the ship turns to your left, Earth drifts off the screen to your right. Continue to watch through the cockpit window as your ship turns and Earth again comes into view from the other side of the screen.
3. When Earth returns to the center of the screen, press keypad 5 to stop rotation.

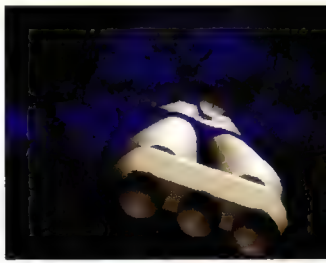
You have just yawed your spacecraft through a full 360 degrees. Try this again, using the right arrow key.

Pitch

For both aircraft and spacecraft, the term *pitch* refers to the up and down movement of the front of the craft. *Pitch up* means that the nose of your spacecraft is rising; *pitch down* means that the nose of the craft is dipping down. Space Simulator uses an aircraft model for pitch control: Press the down arrow key or pull back on the joystick to pitch up; press the up arrow key or push forward on the joystick to pitch down. (You can switch these keyboard controls if it seems more comfortable to you; see "Keyboard Preferences," in Chapter 6.)

Pitching Up 360 Degrees

1. Press the down arrow key 12 times to initiate upward pitch. As the nose of your spacecraft begins pointing upward, Earth starts to fall out of view. The yellow line of the rotation gauge extends upward, and the attitude display's pitch readout climbs. (By the way, there's nothing magical about pressing the down arrow key 12 times. You could have pressed this key once, twice, three times, or more to rotate the craft up. But with 12 keypresses, you get a fairly rapid rate of rotation.)
2. Monitor the cockpit window until Earth appears from the top of your screen. As Earth begins to come into view, you will be completing 360 degrees of rotation.
3. When Earth is again centered in your cockpit window, press keypad 5 to stop pitch rotation.

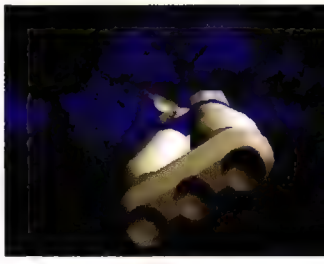


Now use the up arrow key to try another rotation. You can also experiment with different rates of rotation by varying the number of times you press either arrow key.



Roll

The third type of rotation you can use with your spacecraft is called *roll*. When you apply roll, your spacecraft continues to travel in the same direction, but it spins around its longitudinal axis. Sitting inside, you would go from an upright to an upside-down position and then back to an upright position, over and over again until you stop the roll.



You'll find that this rotation is very handy when you are approaching a space station or another spacecraft because you can roll your ship into proper relation with the other object. Roll is indicated visually along the perimeter of the rotation gauge and in the attitude display's roll readout.

To roll left, press the keypad slash (/) key; to roll right, press the keypad asterisk (*) key. Press keypad 5 to stop a roll. Try using these keys now to practice some 360-degree rolls, both left and right. (As alternatives, you can press F9 to roll left

The rotation gauge is registering left roll



and F10 to roll right.) Notice that as your ship begins to roll in one direction, the objects seen through the cockpit window appear to be spinning in the other direction. And be sure to watch the top of the rotation gauge to see how roll is registered.

BEHIND THE SCENES
Flying with Charles

The first time I met Charles Guy, I was flying in the cockpit jumpseat of a Boeing 747. We were over the China Sea, approaching Hong Kong, and Charles was in the pilot's seat.

A Boeing instructor sat behind Charles, coaching him through one of the more difficult landings in commercial aviation. To land in Hong Kong, you basically head straight into a mountain called Checkerboard Hill, which is painted in red and white squares to warn pilots of the very hard right they must make to align themselves for final landing.

Charles was doing pretty well on his approach until he said, "Hang on! I've always wanted to barrel roll one of these!"

The floor went out from under us as everyone grabbed tight and stared straight ahead. The surface of the China Sea was racing upward, and a sense of horror gripped the cockpit as midway through the roll even Charles realized we weren't going to make it. The plane shook like hell as we headed straight into the water. Charles was laughing all the way to impact.

We lived because the Boeing 747 was a full-sized training simulator, housed within an enormous high-security building at Boeing's plant in Seattle, where we had been allowed to pass through the combination-lock doors after hours. As we entered, walking along the balcony of the simulator room, glass walls separated us from the huge mainframe computers that were feeding virtual reality to the simulators. Each cockpit capsule was independently suspended atop one story of hydraulics to create the turns and turbulence.

To get into our capsule, we crossed a drawbridge from the balcony. When the door was closed behind us and the jet engines began to whir, I began to wonder what I had gotten myself into. But Charles was like a child, ready and willing to boldly go anywhere he had never gone before.

▲ ▲ ▲

MISSION: Chasing Down Ring Station 1

Hans Moravec, the great roboticist at Carnegie-Mellon, says that someday intelligent robots will be sent outside to play as part of their learning, just as humans gain much of their learning through playing. In the spirit of playing, let's have a little bit of fun with Ring Station 1.

Playing Around at the Ring Station

1. Choose the Open Situation command from the Options menu, and select our standard FLIGHT situation again. Choose OK.
2. Press the keypad plus sign key just once, to provide a bit of velocity. Ring Station 1 is only a couple of kilometers away, so you don't want too much velocity.
3. Now use any or all of the keyboard controls you've learned about to simply have fun!

Use the left and right arrow keys to yaw left and right. Press the down and up arrow keys to pitch your ship up and down. Try rolling your ship left and right with the keypad slash and asterisk keys. How dizzy can you make your passengers? How close can you come to Ring Station 1 without crashing into it? Play around with your newly gained rotation skills, and see how close you can cut it.

Once you've blasted past Ring Station 1, return to the Options menu, restart the FLIGHT situation, and try taking another run past the outpost. This time, you might want to approach the ring station while keeping it on your left. As you draw alongside, use the left arrow key to exert just enough left yaw to begin curving around the ring station. If it looks like you're about to turn too sharply and yaw in front of the space station, press keypad 5 to stop rotation. Continue using left yaw and keypad 5 to see if you can make it all the way around Ring Station 1.





ASTRONOMICAL NOTE

When long-term human communities are established in space, they might well reside in structures similar to Ring Station 1. The human body doesn't do well without gravity; it needs a local "up" and "down" for reference, especially for extended periods. A ring-shaped space station can be given a rotation that will exert a force on its inhabitants equal to the gravity of Earth. The greater the circumference of the station, the slower, and less noticeable, the rate of rotation can be.

MISSION: Danger! Running the Rings

This mission, should you choose to accept it, is surely illegal, and the residents of Ring Station 1 are certain to complain if any of them happen to look out a port and see you coming. To be responsible, I really should advise you against such foolhardy maneuvers: "Please, don't try to run the rings!" But if you insist . . .

"Running the rings" consists of flying your ship between the two great rings of the space station. It is a rather enjoyable challenge.

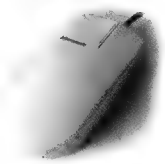
Running the Rings

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. Press the keypad asterisk key to roll your ship right.

   In this position, the two rings of the space station appear vertical, positively inviting you to take your ship through. (You might want to use the Location button, described in the Tech Tip on page 16, to switch to Chase view so that you can see your spacecraft run the rings. For more information about this button and the various views, see "Fun with the Location Button," in Chapter 4.)
3. Press keypad 5 to stop right roll when the space station is centered along the bottom of your cockpit window. (You'll use keypad 5 a lot during this mission.)
4. Press the up arrow key to orient the space station to the center of your cockpit window; press keypad 5 to stop movement when the space station is centered.
5. Use the arrow keys, as well as the roll keys, to align your ship for a passage between the rings.
6. Press keypad plus sign once or twice to apply some thrust.

If you don't succeed the first time you try, reopen the FLIGHT situation and begin again. Good luck! And please drive carefully.

Flying with the Mouse



If you want to fly Space Simulator with a mouse, you might first take a closer look at your life and try to fathom why you would spend what could otherwise be quality time futzing around with the mouse controls. The mouse is great for choosing menus, commands, and buttons, but I definitely prefer flying with keyboard controls or a joystick over flying with the mouse, which is often clumsy and inefficient.

For example, to transform the mouse into a flight yoke (the somewhat steering-wheel-like device that pilots use to control aircraft), you click the right mouse button. Shifting the mouse back out of yoke mode requires another click of the right mouse button. Clicking the left mouse button while in yoke mode simply stops whatever you're doing—you can't use the mouse to choose buttons and menus until you right-click out of yoke mode. Got all that?

Even members of the Space Simulator team avoid flying with the mouse. Lead tester Patrick Wilkinson describes the mouse control as "awkward, confusing, and unpleasant." "But," he adds, "people who fly Flight Simulator with the mouse might like it." So if you are one of those folks, if you are feeling industrious, or if you are simply a mouse fancier, here's how it's done.

Using the Mouse for Flight Maneuvers

1. In the lower right corner of the instrument panel, set the control readout for Rotation, either by clicking the word Control with the left mouse button or by pressing Alt-N. (The readout cycles between Rotation, Thrust, and Panning.)
2. Click the right mouse button. The white mouse pointer disappears from the screen. All movement of your mouse is now translated into rotation of your spacecraft.
3. Watch the rotation gauge and the attitude display on the instrument panel to see the result of mouse movements. The longer the yellow line that extends from the center of the rotation gauge, the more force you have applied to the rotation.
4. After starting a rotation, click the left mouse button once to stop the rotation. The yellow line disappears from the rotation gauge.
5. After stopping a rotation, click the right mouse button once to exit yoke mode and return to pointer mode. The white mouse pointer returns to the screen.



You can adjust the sensitivity of your mouse, which determines how quickly the mouse responds to your movements. Choose the Preferences command from the Options menu, and select Mouse from the Category list. In the Mouse Preferences dialog box, you can set the Mouse Sensitivity scale to adjust responsiveness. The default setting of this scale is 4. Lower settings mean that you must move the mouse farther to cause movement on the screen; higher settings give you a more sensitive mouse with a more rapid response. To change the setting, move to the scale and type the appropriate number (from the main keyboard) or click the scale.

You can also adjust the Mouse Null Zone scale. The mouse null zone refers to the amount of "slack" you have before mouse movements begin to register as intentional movements. The higher the setting, the wider the null zone—and hence the more forgiving and less responsive your mouse will be. This scale also has a default setting of 4.



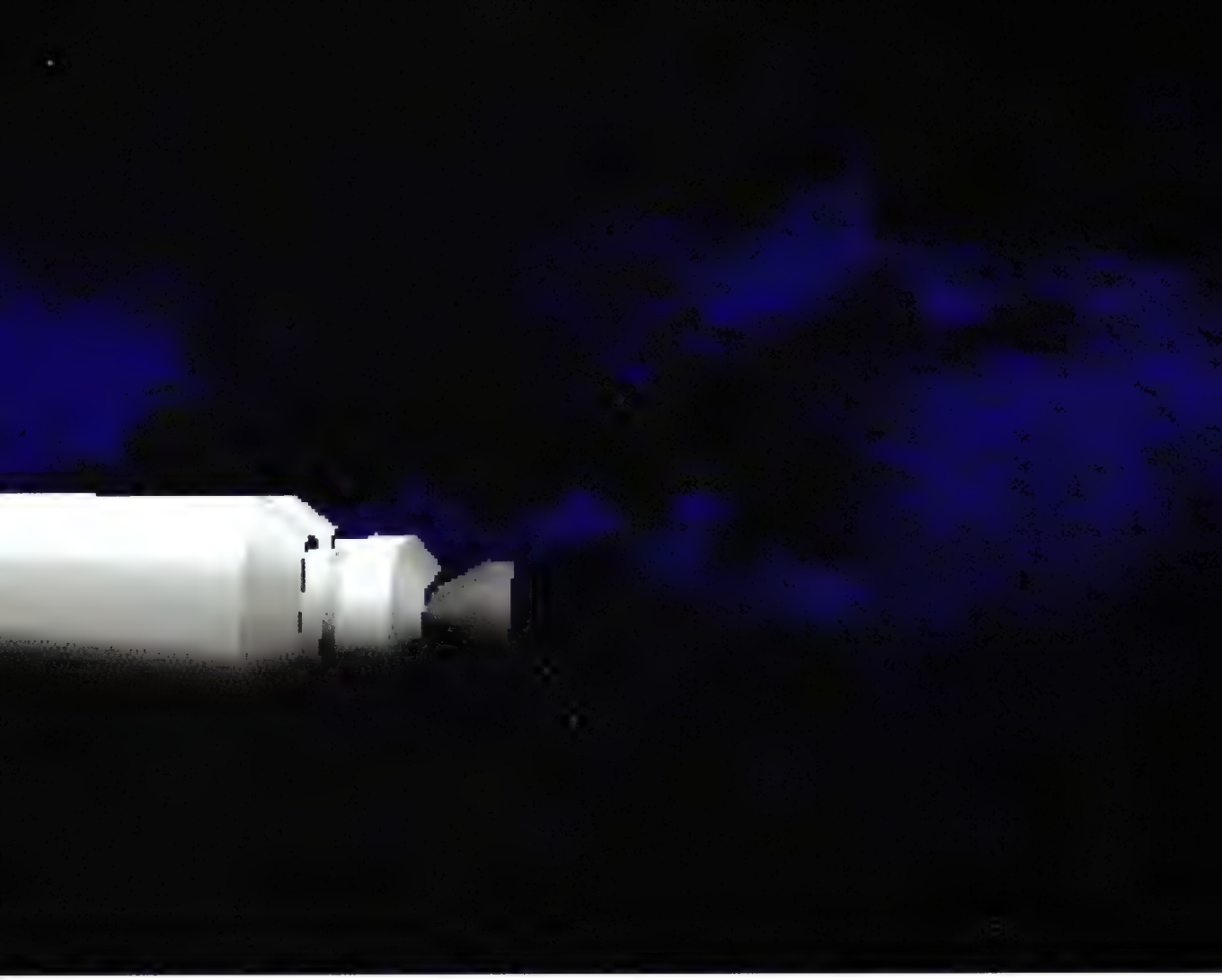
TECH TIP

To move around in a dialog box, press the Tab key until the desired item is selected. To jump directly to an item in a dialog box, either click the item or hold down the Alt key and press the key that matches the underlined letter in the item's name.



Flying with the Joystick

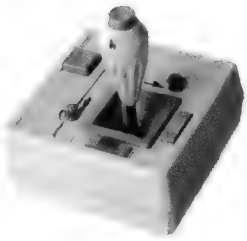
Simply plug a joystick into your computer and fly away—the ship is in your command! Pushing forward on the joystick pitches the nose of your spacecraft down; pulling back pitches up. Likewise, moving the stick left or right yaws your ship left or right. To roll, hold down the Ctrl key on your keyboard and move the stick left or right. That's about all there is to it.



If you like, you can calibrate the joystick or adjust its sensitivity level and null zone, in much the same way you can adjust mouse preferences (explained on page 23). Choose the Preferences command from the Options menu and select Joystick from the Category list to open the Joystick Preferences dialog box. The two scales in this dialog box are just like the scales in the Mouse Preferences dialog box; these scales also have default settings of 4.

TECH TIP

You can turn the joystick on and off in the Joystick Preferences dialog box. It is turned on by default. If you aren't using a joystick, it isn't necessary to turn off this option in the dialog box.



BEHIND THE SCENES
The First Voyage with the Joystick

Many people are familiar with the term "beta software," used to describe software that is still in development and testing, not yet ready to ship as a finished product. Yet even before the beta release of software, there can be a long series of "alpha" releases—the very early stuff.

Even though a new alpha release often means a new assortment of crashing bugs, the alpha releases for Space Simulator were always much anticipated because each successive release usually pushed the door to space open a little bit further. Alpha 4—which for the first time allowed us to fly our spacecraft using a joystick—was such a release.

The evening after it arrived, in March of 1993, program manager Jon Solon carried disks home and loaded it on his machine. He flew through space until after midnight, chasing down planets and orbiting the Moon, excited about being able to leave the keyboard controls behind in favor of the more fluid joystick. Jon, who had been program manager for three versions of Flight Simulator, compared the experience to the first time he took off from Chicago's Meigs Field, circled the skyscrapers, and successfully landed.

All the next day at Microsoft, people were hunting through the storage rooms (and through the offices of their pals) looking for joysticks that weren't being used. There were those who flew, and those who enthused. People were being flagged down and dragged into offices: "I've got to show you something—watch this!" It was a day when the door seemed to open wider than ever before.

▲ ▲ ▲



CRUISING THROUGH SPACE

Get ready for some major good news: Flying is about to get easier!

If you found it difficult to control your ship in the previous chapter, or if you would like to fly more like the space adventurer Buck Rogers and less like the mathematician Sir Isaac Newton, help is on the way. When you turn on Space Simulator's slew control feature, you turn off both gravity's pull and Newton's rules. Without these complications, you'll be amazed at your newfound piloting skills!

Undoing Gravity and Nullifying Newton

Slew control is a clunky name for a tremendous feature. Although veterans of Microsoft Flight Simulator won't have difficulty with the name, the term *slew control* has the sound of a farm irrigation system. Perhaps it should be called the Undo Gravity command, or maybe the Null-Newton command. But no matter its name, slew control makes precision flying infinitely easier and more enjoyable.

Even the rocket scientists among you—those well versed in the mechanics of space flight—might enjoy the ease of flying your great ship with slew control. Even if you are an absolute purist, using slew control occasionally will at least remind you of how daring you are the rest of the time.

Slew control is the "Get Out of Jail Free card" of Space Simulator. When you turn on slew control, you are instantly freed from the gravitational attraction of stars, planets, moons, and other objects of substantial mass. And you get to ignore Newtonian mechanics and turn on a dime without doing Newtonian spinouts across vast expanses of space.

Turning On Slew Control

To turn on this feature, choose the Slew Control command from the Flight menu. Or, as a shortcut, simply press the Y key.

The next time you open the Flight menu, you'll find that the Slew Control command has been replaced by the Flight Control command. Choosing this command (or pressing Y again) turns off slew control and returns you to the "realities" of spaceflight. With slew control turned off, the Slew Control command reappears on the Flight menu, ready for the next time you want to use it.

This sort of one-or-the-other selection, in which you simply move between two states, is called a *toggle*. Pressing Y is the keyboard shortcut that lets you toggle between slew control and flight control.

The Controls Remain the Same (Hooray!)

Fortunately, you can use nearly the same keys to fly your spaceship whether you are slewing or using flight control. For example, pressing the keypad plus sign key increases thrust, and pressing the keypad minus sign key decreases thrust, in both slew control and flight control.

The table below provides a guide to the slew control keys. (You can also display a list of keys on screen by choosing the Keyboard Guide command from the Help menu and then choosing the Slew Control Keys button.)

Slew Control Feature	Key
Thrust	
Apply maximum thrust	End or F8
Increase thrust	Keypad plus sign (+) or F7
Decrease thrust	Keypad minus sign (–) or F6
Cut all thrust	Home or F5
Reverse thrust	Shift-keypad minus sign (–)
Move left	Ins
Move right	Del
Move up	PgUp
Move down	PgDn
Rotation	
Yaw left	Left arrow
Yaw right	Right arrow
Pitch up	Down arrow
Pitch down	Up arrow
Roll left	Keypad slash (/) or F9
Roll right	Keypad asterisk (*) or F10
Stop rotation	Keypad 5 or F3

When you are slewing, the keys that let you move your entire ship left, right, up, and down are the same as those used for fine thrust in flight control. (For information on fine thrust, see "Using the Fine Thrust Gauge," in Chapter 5.)



TECH TIP

In both slew control and flight control, you can use the F5, F6, F7, and F8 keys as alternatives to the keypad keys. When you are flying with the joystick, you might find it easier to adjust acceleration using the F5 through F8 keys.

MISSION: A Scientific Inquiry into the Excellence of Slew Control

For the Space Simulator team at Microsoft, the advent of slew control was a big deal. Because the first few builds of the software didn't contain this feature, all early flights had to be done by the book and under the rule of Newton. So when the developers finally incorporated the code for slew control, it played to a very receptive audience. Before slew control, we were like hotrodders with racing-slick tires driving in the snow. Slew control provided the equivalent of studded snow tires and four-wheel drive.

To help you appreciate the power of slew control, let's try a couple of flights. First we'll fly around Ring Station 1 with slew control turned on, and then we'll try the trip again with flight control. After that, we'll take a look at the Newtonian mechanics behind all that slip-sliding away in flight control.

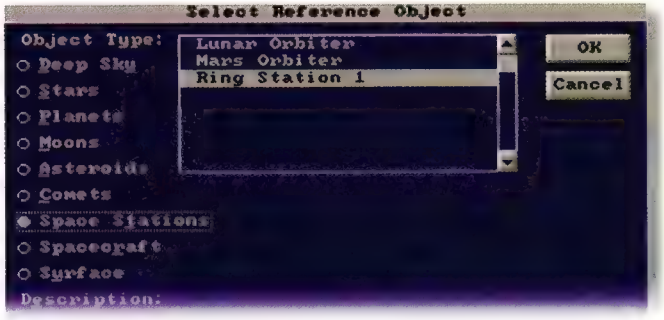


TECH TIP

If you want to give yourself time to think, rest, or investigate a problem during your expeditions, you can press the Pause key to freeze the simulation. To resume exactly where you left off, press Pause again.

Circling Ring Station 1 with Slew Control

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK. You are now in high Earth orbit, just a few kilometers away from Ring Station 1. The reference display on the instrument panel indicates your distance from Earth, your current reference object.
2. To change the reference object to Ring Station 1, choose the reference display by clicking the word Reference on the instrument panel or pressing Alt-R. In the Select Reference Object dialog box, select the Space Stations option button. Then select Ring Station 1 and choose OK. The reference display now shows your distance from Ring Station 1, the new reference object.



3. Choose the Slew Control command from the Flight menu, or press the Y key. You are now flying with slew control, as indicated in the lower right corner of your cockpit window.
4. Press the keypad plus sign key six times. The velocity readout shows your approach to the space station.
5. Use the down and up arrow keys to adjust pitch until your ship is positioned level with the station.
6. Press the left arrow key to keep Ring Station 1 near the left side of your screen. Use keypad 5 to stop rotation. If necessary, press the right arrow key to adjust your turn around the station.
7. Keep the ring station on the left side of your screen as you work your way around it with the arrow keys. As you do so, Earth will disappear along the right of your screen. When Earth rolls back into view from the left, you have completed your circling of Ring Station 1.

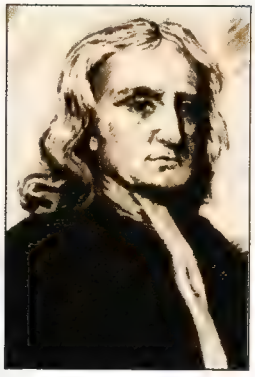
With slew control, circling the space station should have been fairly easy. If you had trouble the first time, try it again. (You might want to try it again anyway; it's a blast to fly a tight circle around this—or any other—space station.)

Circling Ring Station 1 with Flight Control

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK. The FLIGHT situation begins in flight control.
2. Press the keypad plus sign key twice. The velocity reading increases, and your ship nears Ring Station 1.
3. Press the left arrow key to begin the turn toward the space station. Use keypad 5 to stop your rotation.

You didn't make it very far around Ring Station 1, did you? As Sir Isaac Newton figured out a few hundred years ago, when you turn in space you must first cancel the velocity you have attained in one direction before effectively embarking on your new course. Let's take a look at what Newton concluded, as it will affect everything you do in Space Simulator—except when you are using slew control.

MISSION: Spinning Out with Newtonian Physics



Sir Isaac Newton
1642–1727

In the late seventeenth century, Sir Isaac Newton was able to discern the basic mechanics that govern all movement of the known universe. In his classic book *Principia*, Newton described why planets orbited the Sun, why moons orbited the planets, and why, within the vacuum of space, if you threw a recording of Wayne Newton's greatest hits out the window it would continue to fly away from you forever without losing any of its velocity—at least until another life form stopped it, listened to it, and then threw it back. This is Newton's first law of motion, and it applies to everything from bad records to the orbital velocity of entire galaxies.

Of Newton's three laws of motion, it is this first law that most directly affects the piloting of your spaceship: *A body continues at rest or in uniform motion in a straight line unless acted upon by some force*. Thus an object traveling through the vacuum of space can be stopped only if it hits an obstacle or if it becomes gravitationally captured as it passes too near a star, a planet, or a moon.

What this means for flying with flight control is that once you are moving, you can turn your ship completely around to face the direction from which you came, but you will not start moving in that direction until you apply enough thrust to cancel out all the velocity you built up while traveling in the original direction. In contrast, using slew control frees you from this problem.

You can test Newton's first law by traveling in a straight line toward Ring Station 1, passing it, and then reversing your course to move back toward it—and by doing all this with a set amount of thrust, as described here.

Spinning Out in Flight Control

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK. You will again be just a few kilometers from Ring Station 1.
2. Make Ring Station 1 your reference object by choosing the reference display on the instrument panel. (Click the word Reference or press Alt-R.) In the Select Reference Object dialog box, select the Space Stations option button. Then select Ring Station 1 and choose OK.
3. Press the keypad plus sign key three times. Your spacecraft heads toward Earth, skimming past the space station.
4. After you have flown past Ring Station 1, press the left arrow key until you center the space station on your screen. Although you are pointed straight at Ring Station 1 and thrust is still being applied, the instrument panel's velocity readout is decreasing. The velocity continues to decrease until your thrust is sufficient to cancel the velocity you achieved in the previous direction. As this happens, the velocity readout increases again, and you draw near to Ring Station 1.

You have just performed a Newtonian spinout as you chased Ring Station 1 through space. Using the arrow keys for rotation and keypad 5 to cancel rotation, continue to chase the space station. As you do this, watch what happens to the velocity readout. Now try this again using slew control. You will find that your spaceship suddenly turns on a dime.

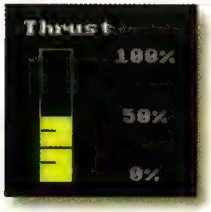
Looking Good with Slew Control

Throughout this book you'll hear a lot about slew control. And what you will most often hear is that whatever you're trying to do, it will be easier with slew control.

This doesn't mean that you shouldn't spend a lot of time using flight control. It simply means that when the going gets tough, a lot of people get going to slew control. Flying with slew control is an excellent way to learn the spacecraft controls. Once you're comfortable with them, you can try the more intriguing and realistic action found with flight control. Because you can use the Y key as a shortcut to swiftly shift between slew control and flight control, you can fly with full space physics and still retain the security blanket of escaping Newtonian limitations with a simple keypress.

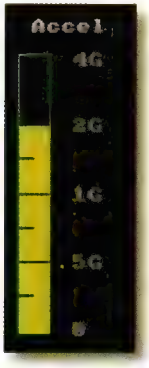
Controlling Velocity in Slew Control

Changing to slew control is a fine way to control the speed at which your spacecraft travels through space. When you are slewing, you double your velocity each time you press the keypad plus sign key. To get a better feel for the benefits of controlling velocity in slew control, let's look at the world of space physics and see how thrust, acceleration, and velocity work together.



Thrust

When you apply *thrust* against an object, you are applying force that propels the object into motion. The amount of thrust applied determines how fast the object accelerates. In other words, thrust produces acceleration. The thrust gauge on the Space Simulator instrument panel shows what percentage of total potential thrust you are applying.



Acceleration

Acceleration, which refers to how much your speed increases or decreases over time, is closely related to thrust. Acceleration is measured in units called *gravities*, or Gs, with 1 gravity being the amount of force required to negate the gravitational pull of Earth at its surface. When you apply enough thrust to create 1 G of acceleration, you will accelerate at a rate of 9.8 meters per second per second—that is, within the first second after you apply 1 G of thrust from a standing start, you will travel 9.8 meters; after another second, you will be traveling at a rate of 19.6 meters per second; after the third second, you will reach a velocity of 29.4 meters per second. Space Simulator's acceleration gauge maxes out at 4 Gs, high enough for all the spacecraft except the superfast F-79 Galactic Fighter, which can accelerate up to 8 Gs (even though you can't see this on the acceleration gauge).



Velocity

While acceleration is a measure of the amount of change in speed, the term *velocity* simply refers to the current speed at which you are traveling—55 miles per hour on the interstate, for example, or 200,000 kilometers per hour through the galaxy.

Space Simulator's instrument panel provides a readout for two types of velocity: tangential and radial. To understand the difference between the two, consider a bicycle wheel. Let's say that Earth is at the hub of the wheel and that it is your reference object. Traveling along the rim of the bicycle tire registers tangential velocity, as your movement is tangential to the reference object. Traveling down

a spoke, going from the tire to the hub, registers radial velocity, as you are traveling along a radius directly toward the reference object. The radial velocity display also indicates whether you are traveling toward or away from the reference object. Depending on your course, you'll usually have both tangential and radial velocity.

For a more general indication of your speed, click the velocity display or press Alt-V. A new readout shows combined, or "true," velocity, which is determined by adding the square of the radial velocity to the square of the tangential velocity and taking the square root of the sum. This display also includes a gauge showing your velocity as a percentage of the speed of light, or "C."

You can cut your engine's thrust and watch acceleration fall to 0, but because of Newton's first law of motion (a body continues to move in a straight line unless acted upon by some force), your ship's velocity remains the same. The velocity does not decrease unless you apply reverse thrust or in some other way apply a force against your spacecraft's current vector of velocity (such as running it into a space station or a planet).

Investigating Thrust, Acceleration, and Velocity

1. If you are in slew control, choose the Flight Control command from the Flight menu, or press Y. Using flight control will allow you to clearly see the relation of thrust, acceleration, and velocity.
2. Choose the Moons command from the Location menu. In the dialog box, select Callisto and choose OK. You are now 7,200 kilometers from the surface of the most distant of Jupiter's Galilean moons.
3. Press the keypad plus sign key eight times, bringing the acceleration gauge up to 1 G. Notice how the thrust and acceleration gauges rise, and watch the velocity readout increase.
4. Press the keypad plus sign key again, increasing acceleration to 2 Gs. As you fly, enjoy your view of the brown, heavily cratered surface of Callisto.
5. Press the keypad minus sign key several times to reduce acceleration back to 1 G. The thrust gauge goes down, and the increase in velocity slows. Remember that to decrease velocity when you are using flight control, you must reverse the ship's direction and apply thrust.

Continue to play around with the keypad plus sign and minus sign keys, increasing and decreasing the amount of thrust and watching the reaction of the acceleration gauge and the velocity readout. Then try increasing thrust to bring acceleration to the maximum 4 Gs. Now watch how long it takes to achieve a velocity of 10 or 20 kilometers per second. In contrast, you'll find that you can change velocity much more quickly while flying in slew control.



ASTRONOMICAL NOTE

Callisto is one of the four great "Galilean moons" of Jupiter. In 1610 the astronomer Galileo used the world's first telescope, which he had invented the year before, to discover Jupiter's four largest moons. In order of their proximity to Jupiter, the Galilean moons are Io, Europa, Ganymede, and Callisto. Jupiter also has at least a dozen smaller moons.



TECH TIP

After you press keypad plus sign 32 times to max out your velocity in slew control, you can bring velocity back to 0 by pressing keypad minus sign 32 times—or you can do it the easy way by simply pressing F5 (or Home), which cuts all thrust. F8 is another powerful key: It lets you reach maximum velocity without having to press keypad plus sign 32 times. (You can do the same thing by pressing the End key.)

Changing Velocity in Slew Control

Changing your velocity in slew control is easy and quick: Just press the keypad plus sign key to increase thrust or the keypad minus sign key to decrease it. Remember that when slew control is turned on, you can double your velocity by pressing keypad plus sign.

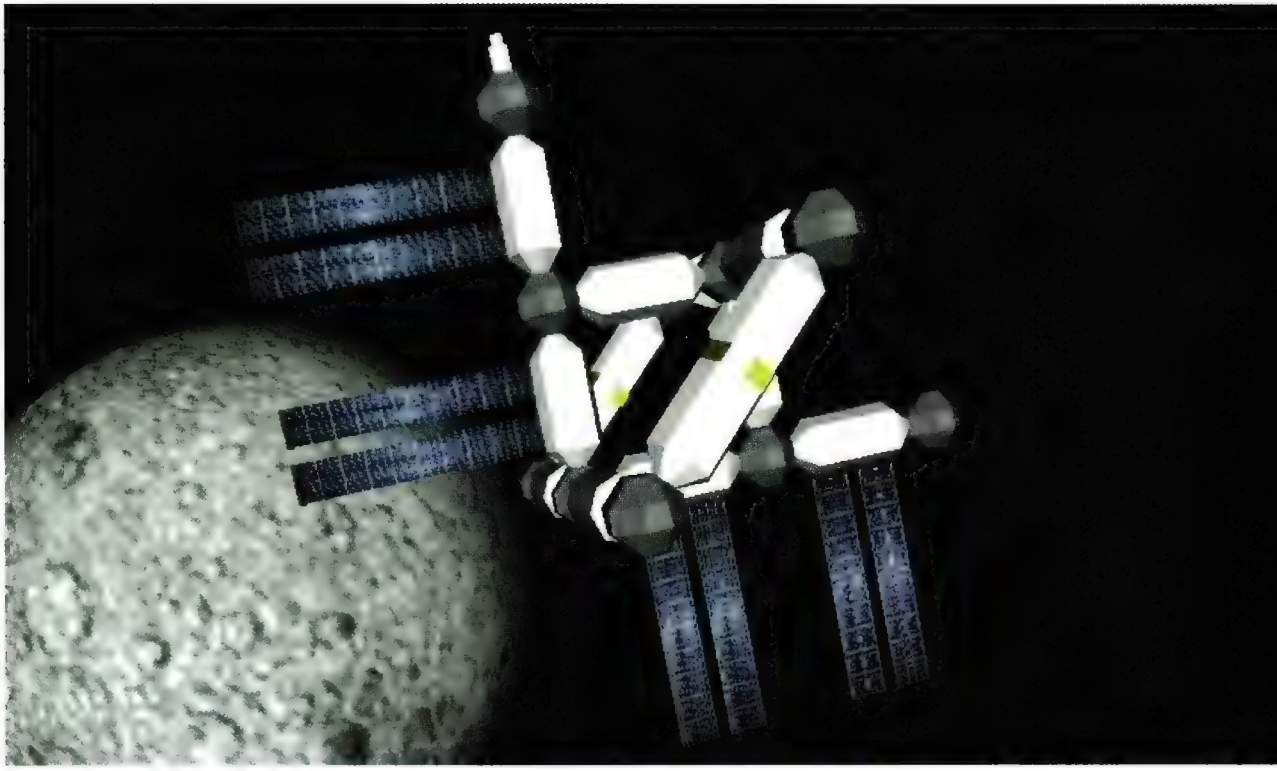
To try this out, begin by pressing the Y key to change to slew control. Then press F5 and F4 to set the velocity readout to 0.000 meters per second. (Pressing F5 cuts all thrust, and pressing F4 zeroes velocity.) When you press keypad plus sign once, the velocity rises to 0.279 meter per second. Press the key again, and the velocity doubles to 0.558 meter per second. Continue to press keypad plus sign, and watch the velocity double each time. (Once the speed exceeds 999 meters per second, the velocity readout display shifts to kilometers per second.)

The power of doubling is such that with several keypresses you can reach 585 kilometers per second, and then 1,171 kilometers per second, and onward until you max out, after 32 presses, at 299,792 kilometers per second. This maximum velocity is just below the speed of light—which, if you want to be precise, is 299,792.458 kilometers per second. (Under flight control, accelerating at the maximum thrust of 4 Gs, it would take you nearly 9 days to reach this velocity.) Play around with the keypad plus and minus sign keys in slew control, increasing and decreasing your velocity.

Reversing Thrust in Slew Control

When you are slewing, pressing the keypad minus sign key reduces thrust but does not reverse it. If you want to reverse thrust—for example, to back away from a space station or a planet—press Shift-keypad minus sign. Each time you press this key combination, you double your velocity in the reverse direction. If you're really in a hurry, you can take reverse thrust up to the same virtual light speed you can reach with forward thrust.

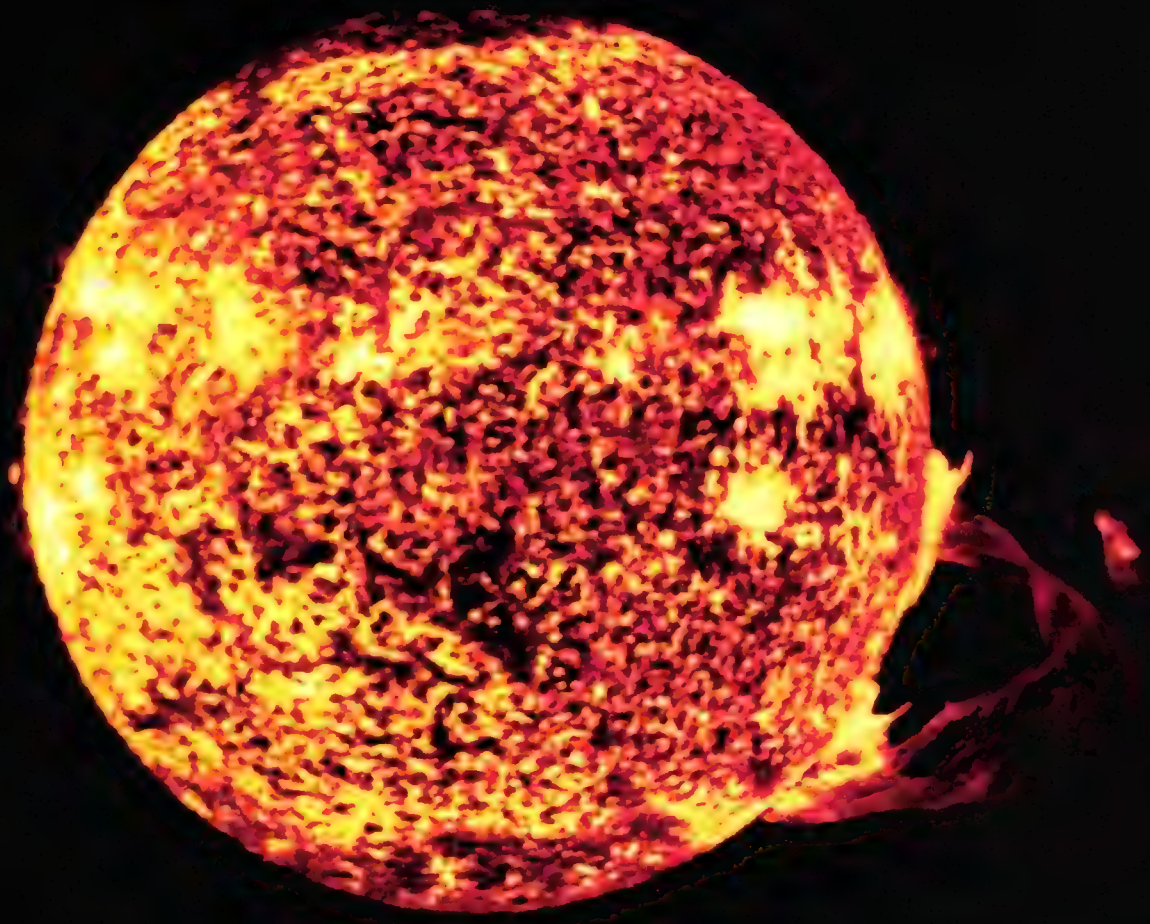
Go ahead and experiment with forward and reverse thrust in slew control. Then test your skills by maneuvering around a space station such as the Lunar Orbiter.



Close Maneuvering Around the Lunar Orbiter

1. Choose the Space Stations command from the Location menu. In the dialog box, select Lunar Orbiter and choose OK. You are now less than 1 kilometer away from the Lunar Orbiter space station, which is located some 5,000 kilometers above the surface of the Moon.
2. Choose the Slew Control command from the Flight menu, or press the Y key.
3. Press keypad plus sign three times. As you near the Lunar Orbiter, watch the instrument panel's altitude readout decrease.
4. When you are within 200 meters of the space station, press F5 to stop all thrust. You can go closer if you want, but be careful—no collisions!
5. Press Shift-keypad minus sign two or three times to begin backing away from the space station. Watch the altitude readout increase as your spaceship backs away.
6. To stop your reverse thrust, press F5.

Go back and forth around the Lunar Orbiter until you feel comfortable with using forward and reverse thrust together for precision maneuvers.



Controlling Gravity in Slew Control

In Space Simulator, all stars, planets, moons, asteroids, and other large bodies exert the precise gravitational attraction that is proportional to their mass. Get too near the Sun, for example, and there is no escape! Once the gravitational force of an object exceeds 4 Gs (the maximum thrust of your ship), you are a captive. Even without such dire consequences, however, flying around in gravity is an adventure.

For those times when you don't want to bother compensating for gravity, all you have to do is turn on slew control. Slew control is great for protecting yourself from the forces of gravity you'll encounter around large objects.

Experimenting with Gravity Near the Sun

1. Choose the Stars command from the Location menu. In the dialog box, select Our Sun and choose OK. You are now about 2.8 million kilometers away from the Sun. Even at this distance, you are subject to a lot of gravitational pull.
2. Choose the Slew Control command from the Flight menu, or press Y. While you are slewing, the velocity readout remains unchanged. Your ship won't be affected by the gravitational pull of the Sun.

3. Choose the Flight Control command from the Flight menu, or press Y. With flight control turned on (and slew control turned off), notice the rapid increase in velocity. No thrust has been applied to your spacecraft; this velocity is being generated by the gravitational attraction of the Sun.
4. Watch the velocity readout build to a few kilometers per second, and then turn on slew control again to stop the gravitational pull on your spacecraft.

When you are slewing, you can increase your velocity to about 9,000 kilometers per second, reduce your distance from the Sun by several hundred thousand kilometers, and then press F5 to cut all thrust and reduce velocity to 0. If you leave slew control for flight control at this point, you'll see the velocity readout increase at an even greater rate because you are now closer to the mass of the Sun. You might enjoy experimenting to see how quickly your ship accelerates to 1 kilometer per second at various positions nearer the surface of the Sun.

BEHIND THE SCENES
Creating a Revolution?

One sunny Sunday morning, Charles Guy, Jon Solon, and I sat on the deck of Jon's house, atop a ridge that steeply yet gracefully tumbles down to the water of the lake. There was beauty all around us: The sky was blue, the lake was sparkling, and the land between the water and us was covered with the apple trees of a hillside orchard. Yet what we talked about, in a sense, was how to leave this all behind, how to get eyes, minds, imaginations, and spirits off the planet and into space, via Space Simulator. We joked about a new generation of kids, raised on the adventures of Space Simulator, marching someday to confront their elected leaders. The cry would be "We want space, and we want it now!"

In a fanciful, kidding mood, Charles once said of his creation: "It might bring on a whole new social revolution!" We might hope that it could bring a spiritual evolution as well. Perhaps a tool to simulate even a part of the vastness of space will lead us to ponder what that vastness might mean for humanity, as we glide through the soft darkness of space, clutching hold of our garden planet in orbit around our gracious middle-aged Sun.

> ***"Hesper—Venus—were we native to that splendour or in Mars,***
> ***We should see the Globe we groan in, fairest of their evening stars.***
> ***Could we dream of wars and carnage, craft and madness, lust and spite,***
> ***Roaring London, raving Paris, in that point of peaceful light?"***
>
> *—Alfred Lord Tennyson, "Locksley Hall Sixty Years After"*

MISSION: Using Time as Your Throttle

"Albert Einstein . . . wondered what it would feel like to travel on a beam of light, to flash signals between passing spaceships, or to fall weightlessly in a runaway room through the chasm of space between the stars. From such childlike thoughts flowed Einstein's theories of relativity. . . . Einstein's will remain a name to conjure with, to the farthest reaches of the Galaxy."

—Nigel Calder, *Spaceships of the Mind*

Tucked away in the lower left corner of the instrument panel is the most powerful navigational feature of Space Simulator: the time scale. This scale is your magic carpet for exploring the boundless realms of space.



The speed of light defies the imagination: nearly 300,000 kilometers (more than 186,000 miles) per second. Travel at that incredible speed nonstop for an entire year, and you've covered a distance that is known as a light-year, nearly 9.5 trillion kilometers (about 6 trillion miles). One might think that a vehicle capable of traveling at the speed of light (which Einstein believed to be impossible) would provide all the mobility one would need to explore all of space. But the reaches of space are so vast that even a light-speed ship is pathetically inadequate for visiting anything beyond our solar system; a trip from Earth to the center of the Milky Way galaxy, for example, would require more than 30,000 years.

But don't take my word for it. Let's give it a try right now by setting a course for one of our nearest stellar neighbors, Alpha Centauri, and traveling there at virtually the speed of light.

Setting a Course for Alpha Centauri

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT, and then choose OK to return to our familiar Earth orbit.
2. Choose the Preferences command from the Options menu. In the dialog box, select the Labels option button. Then select Stars and choose OK. Your screen now displays the names of stars.
3. Press Y to turn on slew control. If you want to see your ship as you fly, you can also click the Location button to switch to Chase view.



4. Press the right arrow key until Alpha Centauri appears in the center of your screen. Then press keypad 5 to stop movement. You're ready to begin your journey to Alpha Centauri.
5. Press F8. You are now traveling at just below the speed of light.

Sit back and enjoy the view as you rocket your way toward Alpha Centauri. Be sure that you're sitting in a comfortable chair and that you have plenty to eat. Even if you're flying at the speed of light, you'll be watching that monitor for 4.3 years until you arrive. And should you decide to travel to another star—for example, Betelgeuse, which is 520 light-years away—you will need to keep your computer running and yourself alive and healthy for more than five centuries. This is why the time scale is the ultimate throttle.

ASTRONOMICAL NOTE

Although science fiction writers have long celebrated Alpha Centauri as our nearest neighbor, its very close companion Proxima Centauri is actually 1 trillion miles closer to Earth.

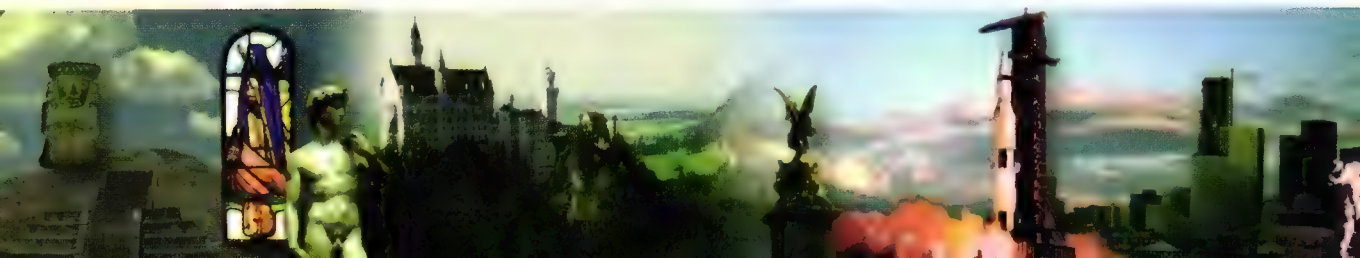
Changing the Time Scale

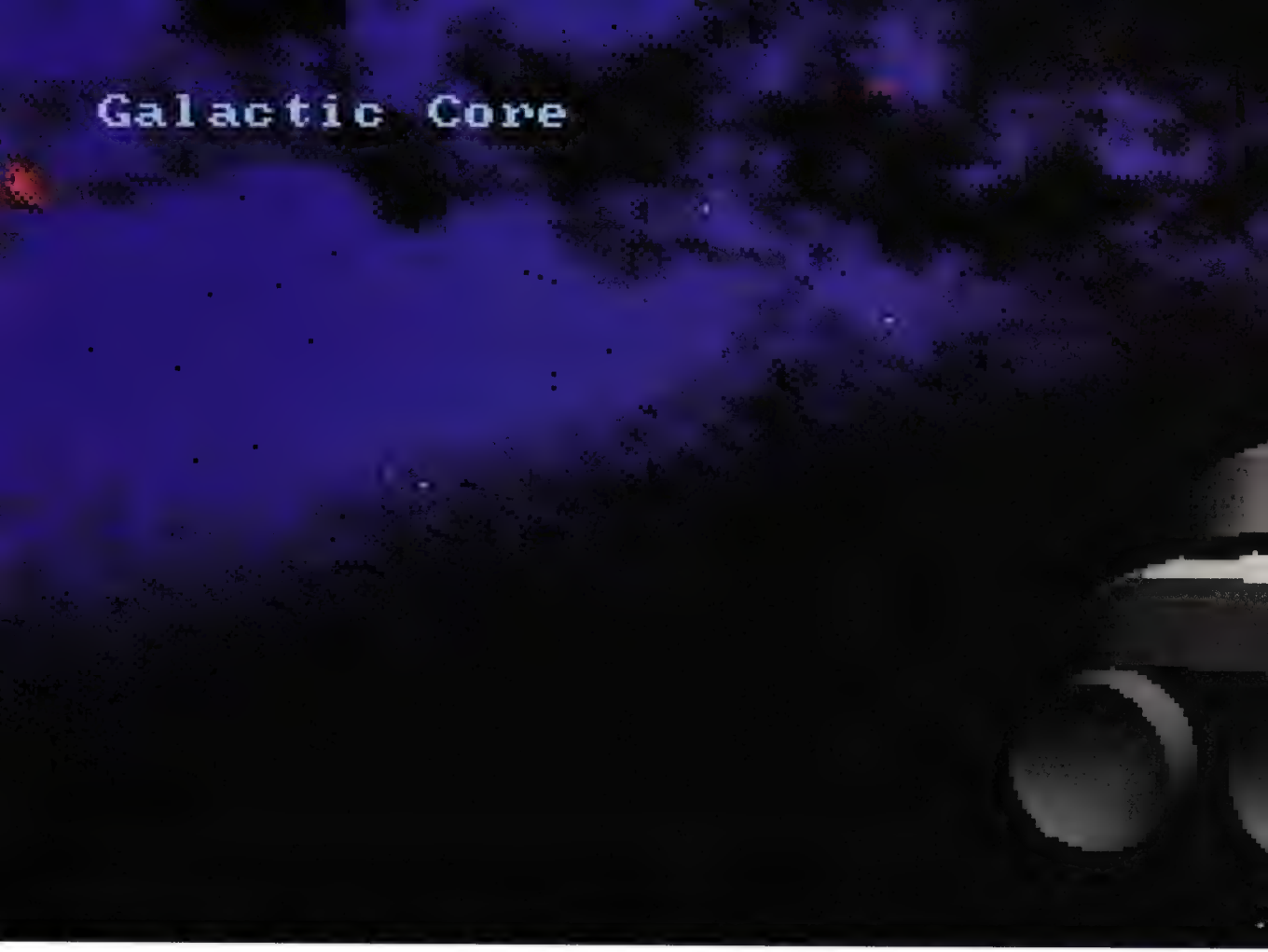
1. Press F1 or click the time scale's up arrow. Each keypress or click doubles the speed at which time passes. With the first keypress or click, the simulation time passes at 2 seconds per second; with the second keypress or click, time passes at 4 seconds per second; with the third, 8 seconds per second, and so on.
2. To slow the time scale, press F2 or click the time scale's down arrow. In this case, each keypress or click halves the speed at which time passes.

You can easily see the power of doubling: After only 38 presses of F1 or clicks on the time scale's up arrow, the passage of time has advanced to the maximum rate of 8,710.5 years per second. (For a speedier way to adjust the time scale upward, press Shift-F1 to immediately increase the time scale to a rate of 1.1 years per second. To quickly return to a normal setting of 1 second per second, press Shift-F2.)

Flying to Alpha Centauri Using the Time Scale

1. You'll need to reset your course to Alpha Centauri. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. If the names of stars are not displayed on your screen, choose the Preferences command from the Options menu. In the dialog box, select the Labels option button. Then select Stars and choose OK.







TECH TIP

You can choose a display on the instrument panel (such as the reference or the time display) either by clicking on its name or by holding down the Alt key and pressing the key that matches the underlined letter in the display name.

3. Make Alpha Centauri your reference object by choosing the reference display on the instrument panel. In the Select Reference Object dialog box, select the Stars option button. Then select Alpha Centauri and choose OK. The distance readout now displays the distance to Alpha Centauri.
4. Press Y to turn on slew control.
5. Press the right arrow key until Alpha Centauri appears in the center of your screen. Then press keypad 5 to stop rotational movement. Once again you are ready to begin your journey to Alpha Centauri.
6. Press the keypad plus sign key several times to increase the velocity to nearly 75,000 kilometers per second. This velocity is about one-quarter the speed of light. Going much faster than this will make the steering controls pretty skittish after you advance the time scale setting.
7. Press F1 or click the time scale's up arrow to increase the time scale setting to 48.5 days per second.
8. Use the arrow keys and keypad 5 to keep Alpha Centauri centered on your screen.

Monitor the distance readout to watch your progression toward Alpha Centauri. You can increase the time scale setting if you would like to travel faster. And, by the way, check out what is happening to the instrument panel's readout of the date.



Changing Time and Light

Occasionally you might choose a destination—a planet, for example—only to arrive at what appears to be a black hole in space. Don't worry—you're just experiencing the realism of Space Simulator. Take a closer look, and you'll probably find that the black area on your screen contains no stars. What's happened is that you've arrived at a date and time when the planet isn't being lit by its sun. To change the lighting and make the planet visible, all you need to do is change the date or time.

To view a planet, a moon, or another object in better light, first switch to slew control (so that your ship doesn't fly out of orbit), and then press F1 several times or click the time scale's up arrow to advance the passage of time until the lighting improves. Be ready to hit the Pause key or press F2 to slow time when the object is well lit. You can also choose the time display on the instrument panel and experiment with changing the date in the Time dialog box until you find better light.

Be sure to jot down the dates that have good sunlight so that the next time you visit you can simply open the Time dialog box and enter one of the new dates. You'll find that you can not only enhance your view but also create some very dramatic effects by altering lighting.

BEHIND THE SCENES
Meditations at 68 Years Per Second

Many of our early voyages with Space Simulator carried us to the center of the galaxy, and sometimes beyond, which would mean that we had the time scale jacked up to mind-boggling speeds of hundreds or even thousands of years per second. We'd be so absorbed in what we were seeing that not until late in the voyage would someone say: "Look at the date!"

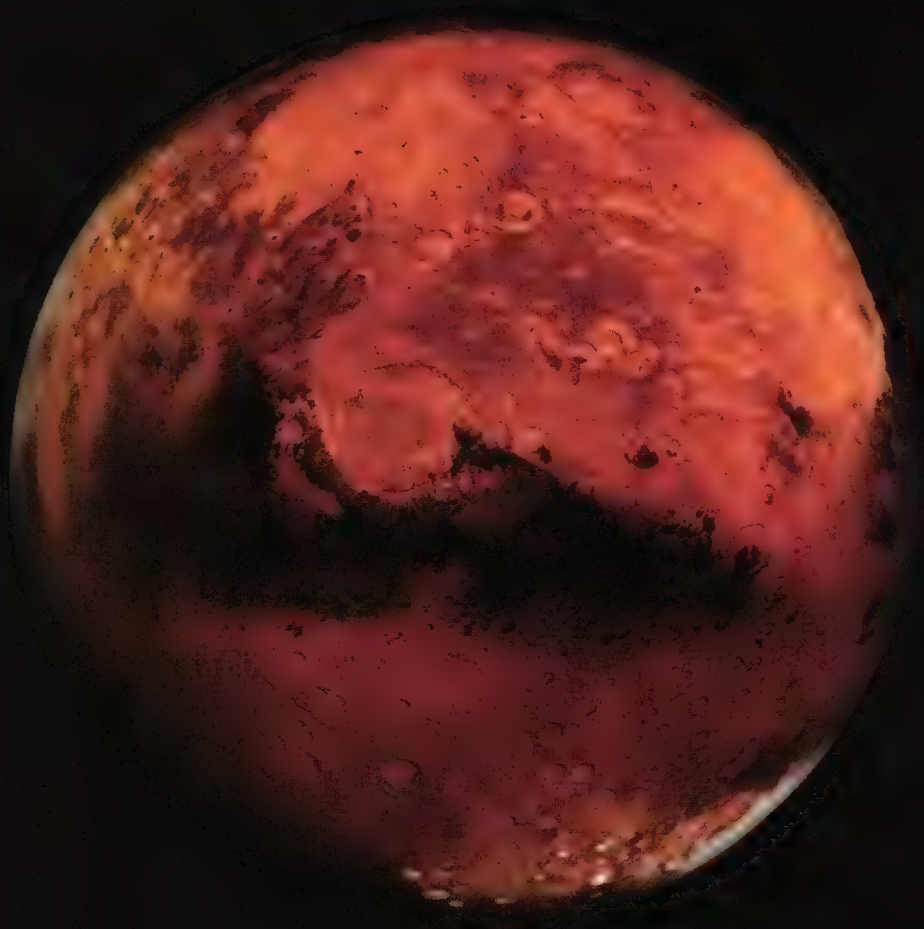
And there it would be: 433689, or another crazy-looking year we could neither fully comprehend nor even pronounce. Many of us quake (with either grand anticipation or cold fear) to think what might lie 50 years in the future. But here, as if in a time machine, we'd look down and notice we were suddenly in the year 1034916.

Seeing the dates flash by provides the wonderful suggestion that life might continue so long. But it also raises the question of what knowledge humans might possess in the year 1034916. Would life on Earth still include humans? Would we have the wisdom of galactic gods? Or would we be just another emanation of life, emerging from another disaster?

For me, the most poignant time scale setting wasn't one of hundreds or thousands of years per second, but the setting of 68 years per second. As I sat there counting the seconds off and watching how slowly, how nearly imperceptibly the ship progressed into the stars, I would consider that in each second one spacefaring captain would have spent an entire career at the helm. Each second that passed was a professional lifetime, nearly an entire lifetime.

It was while traveling the stars at a time scale setting of 68 years per second that I most fully understood the vastness of our galaxy and the brevity of our lives.







4

THE JOY OF JUST LOOKING AROUND

Space has a haunting beauty about it that, for all the centuries of human minds trying to figure it out, still remains unfathomably mysterious and perhaps forever unknowable.

But with Space Simulator, you can at least look around. This is a sort of pragmatic—and perhaps even hedonistic—approach to enjoying space, as well as life.

On the one hand, we can fret about whether the Big Bang really began the universe and whether we are all part of some cosmic internal-combustion engine puttering along, one big bang after the next, while we, the perplexed occupants of a single explosive cloud, spend our flash of existence trying to puzzle out why we were born and what we ought to be doing. (Meanwhile, the driver of this vast contraption might be muttering about how loud the engine has become, thinking that perhaps the mixture should be leaned: "Maybe a little less hydrogen . . .")

Or, on the other hand, we can accept the mere fact of our existence as being a celestial invitation to live life with such adventure and joy that the domain of the Big Bang becomes our playground rather than a puzzle.

With this approach in mind, here's a chapter about the simple concept of looking around, about *seeing* what's out there once you get there. In this chapter, you'll learn how to wring the very most out of Space Simulator's excellent view tools and its Window menu.

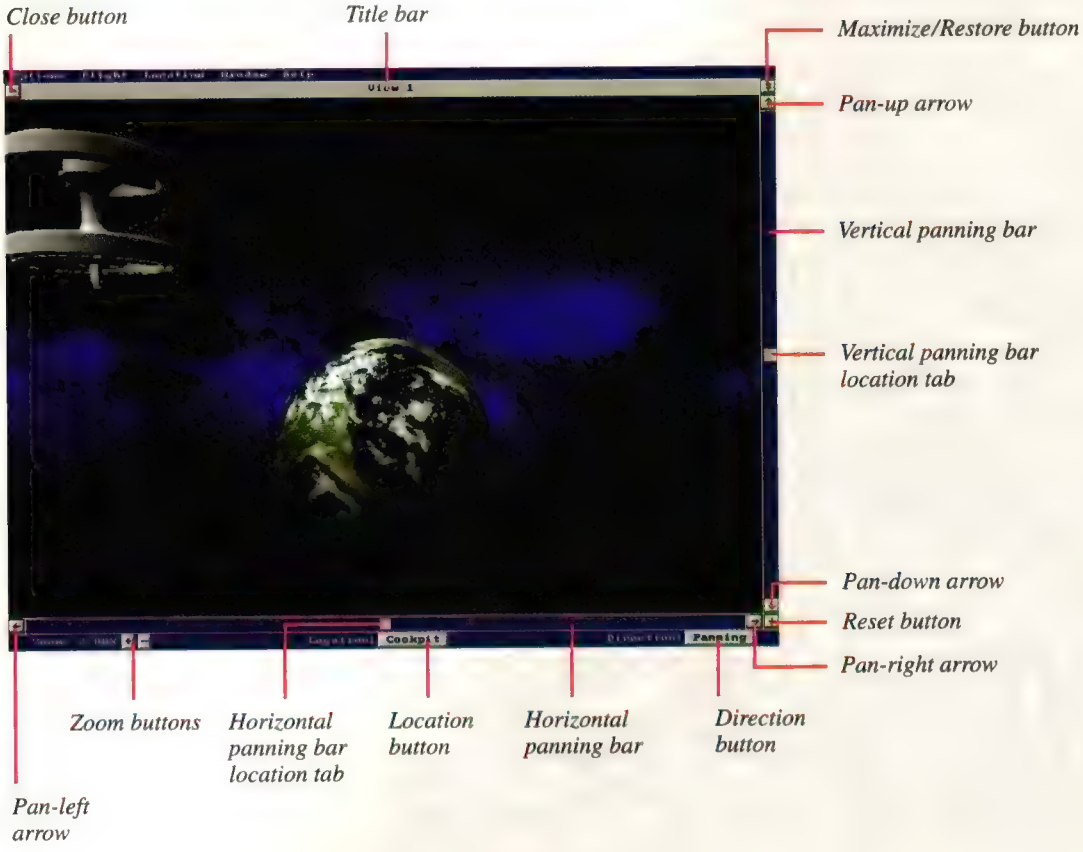


TECH TIP

If the view tools aren't displayed on your screen, choose the Show View Tools command from the Window menu. (For more information, see "Using the Show/Hide Toggle Commands," later in this chapter.)

Looking Out Your Cockpit Window

When you launch an adventure in Space Simulator, you do so with a fine spacecraft designed to enhance your powers of exploration. As you sit before your cockpit window, you have at your command view tools that provide you with wraparound vision and other abilities, including the power to greatly alter the magnification of your vision by zooming in and out. The illustration below offers an overview of the view tools.



Seeing the Sights with the Panning Bars

Space Simulator's magnificent cockpit window provides a complete wraparound view, both horizontally and vertically. Click anywhere along the blue horizontal panning bar, and it is as if you had just turned your head to look out that portion of the window; the scenery outside shifts to reflect the new view. Click either end of this panning bar, and you look directly out the back of your ship. To see what is above or below you, click along the vertical panning bar. In effect, all of your ships are equipped with glass ceilings and glass floors! Let's look at some of the specific tools you can use.

Horizontal and Vertical Panning Bars

When you click any location on a panning bar, your view shifts to the perspective you would have from the corresponding position in the cockpit. With the horizontal panning bar, you can imagine walking around your cockpit, looking out a window wherever you click. By clicking either the extreme left or right end of the horizontal panning bar (but not the arrows), you can look directly behind your ship. Click the center of this panning bar to look directly out the front of the ship.
If you click the upper end of the vertical panning bar, it is as if you were floating up to the top of your wraparound cockpit window. To see space through the "glass floor" on the bottom of your ship, click the lower end of this panning bar.

Panning Bar Arrows

Both the horizontal and vertical panning bars have arrows at each end. Click these arrows to incrementally move, or change, your viewing position. For a greater degree of adjustment, point to the arrow, press and hold down the left mouse button, and then release it when you are satisfied with the new view.

Panning Bar Location Tabs

Both panning bars have a gray tab that indicates your current viewing location along the bar. When the gray location tab is at the far end of the horizontal panning bar, for example, you are looking out your cockpit's rear window. You can also shift your view by dragging the location tab along the panning bar: Point to the tab, and then press and hold down the left mouse button while you move the tab. After you move a tab, you'll notice a blue square in the middle of the panning bar; click this square to return the tab to the center of the bar.



TECH TIP

Another way to reset panning bars to the centered position is to press Alt-keypad 5.

Reset Button

The handy Reset button returns your view to a position looking straight out the front of the cockpit. Click the Reset button once to bring the location tabs on both panning bars to their centered home positions.

Maximize/Restore Button

The Maximize button expands your view window, hiding the instrument panel. After you click the Maximize button, it toggles to become the Restore button. Clicking the Restore button returns the instrument panel to the screen and reduces the size of your view.

Close Button

The Close button hides your view window and leaves the instrument panel on the screen. To restore your view window, choose Show View 1 from the Window menu or, as a shortcut, simply press the 1 key on the main keyboard. When two view windows are open, you can click the Close button in one of the windows to close it quickly, allowing the remaining window to expand into the additional space. (For a discussion of view windows, see "Taking a Closer Look at the Window Menu," later in this chapter.)

Title Bar

The title bar of your view window helps you keep track of which view you're seeing. It's especially useful when you have two or three view windows open, such as View 1, View 2, and Map view, or when you want to move between several of these windows.

Four Ways to Change Your View

The ability to adjust your perspective with the panning bars is so important to the enjoyment of your explorations that Space Simulator offers several different ways to change the view. Here's a summary of the four methods you're likely to employ most often, including one that lets you use the keyboard rather than the mouse:

- Click anywhere along a panning bar.
- Drag the location tab to a new point on the panning bar.
- Click a panning bar arrow, or briefly hold down the mouse button over the arrow.
- Press Alt-right arrow key or Alt-left arrow key to move your view to the right or the left; press Alt-up arrow key or Alt-down arrow key to move your view up or down. This keyboard method is my own favorite. It simply feels like a smooth and logical way of controlling the view from the cockpit.

Power Panning

Another quick and convenient way to change your view is to use "power panning," in which you hold down the Shift key and press a numbered keypad key. The arrangement of the numbered keys on the keypad corresponds to the "location" of various windows in your cockpit: For instance, press Shift-keypad 2 to look out your ship's back window, or press Shift-keypad 6 to see the view from a right-hand window. Each shifted keypad number key provides a different view (with the exception of the 5 key; remember that Alt-keypad 5 recenters your view). You can power pan in Cockpit, Chase, or Assigned view.

MISSION: Walking Around the Cockpit

Here's a simple mission that will help you see the value of the panning bars. You'll fly past Ring Station 1 and then use the horizontal panning bar to find the space station behind you, after it has left your view. It will be like turning your head from the front cockpit window to the side windows, and then to the rear window.

Watching Ring Station 1 As You Fly Past It

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. Press the keypad plus sign key four times. Your craft kicks into gear, and you head toward Ring Station 1. If you are flying in slew control, you might want to add more thrust to speed things up.
3. Use the down and up arrow keys to send your ship up toward the station.
4. As Ring Station 1 drifts off the left side of the screen, press Alt-left arrow key. The gray location tab on the horizontal panning bar moves as Ring Station 1 comes back into view. You are now looking out a side window of your cockpit.
5. Continue to press Alt-left arrow key to keep Ring Station 1 in view. The space station becomes smaller as you fly away from it, even though you continue to keep it in view by looking out the side and finally the rear windows of the cockpit.
6. Press Alt-left arrow key until the location tab travels all the way to the left end of the horizontal panning bar. At this point, you are looking directly out the rear window. If you now move the location tab to the opposite end of the panning bar (by clicking the right end of the bar), you can still see Ring Station 1 because both ends of the bar show the same view out the rear window.
7. Click the Reset button, or click the blue square in the center of the horizontal panning bar. Earth is back in view, but you can no longer see Ring Station 1, which is now behind you.

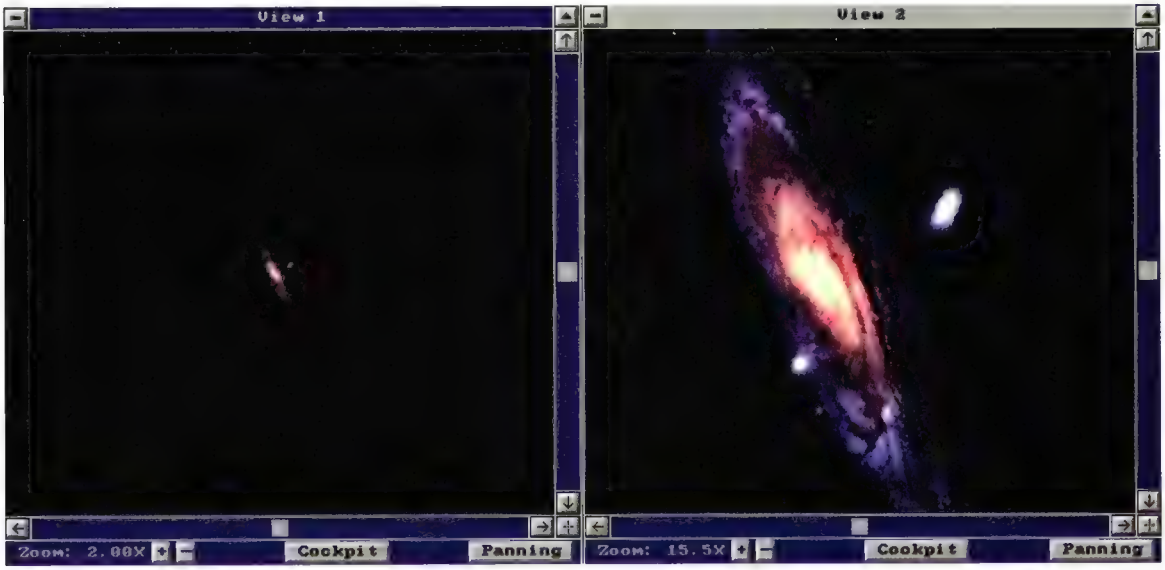
8. Press the left arrow key to turn your spacecraft until you have the space station in view. By using the left arrow key without the Alt key, you are actually turning your ship rather than shifting your point of view. With thrust still applied, you can now begin chasing down Ring Station 1. (If you're flying with flight control rather than slew control, however, you must allow time for the new direction of thrust to cancel your existing velocity before you can take off in a new direction.)

These simple panning bars offer you extraordinary powers of observation. But there's more. As you sit in the cockpit of your spacecraft, you have three additional view tools at your command, located just above your instrument panel: the Zoom, Location, and Direction buttons.



The Power of Zoom

Zoom is like having a telescope built into your cockpit window. No great starship should be without it. If you want a closer view of an object, zoom in; for a wider field of vision, zoom out. You can zoom in on anything at any time.



On the left, the galaxy Andromeda appears tiny at a zoom factor of 2.00; on the right, a zoom factor of 15.5 provides a good view of our galactic neighbor.

TECH TIP

Although a setting of 1.00 might seem more logical, Space Simulator's standard zoom setting is 2.00. In fact, objects look distorted at a 1.00 zoom factor (a "fish-eye" effect). The developers of Space Simulator decided to have a setting of 2.00 match the natural field of view that is seen by the unaided human eye.

The zoom readout on the lower edge of the view window shows the current zoom factor. To increase the zoom factor (that is, to zoom in), click the Zoom plus sign button. The more you click this button, the greater the zoom factor. To reduce your zoom factor, click the Zoom minus sign button.

You can also press the plus sign key on the main keyboard to increase zoom or the minus sign key to reduce zoom. (Be sure that you don't confuse these keys with the keypad minus sign and plus sign keys, which control thrust.) To quickly return to the normal zoom setting of 2.00, press the zero key on the main keyboard.

To try out the zoom feature, let's go to Neptune and zoom in on its surface.

ASTRONOMICALLY SPEAKING

Neptune: The Color of Mythology

The blue beauty Neptune is the eighth planet out from our Sun (although it is actually the farthest from the Sun until 1999, when Pluto's elliptical orbit again moves beyond Neptune). The discovery of Neptune was an international triumph of mathematics and astronomy. French astronomer U. J. J. Leverrier and British astronomer John Couch Adams, working independently, were studying certain unexpected changes in the orbit of the planet Uranus. In 1846, each researcher predicted the existence of another planet—and also accurately predicted where it would be. That same year, a German astronomer, Johann Gottfried Galle, used this information to discover that our solar system did in fact contain another planet. News of the discovery of Neptune caused excitement around the world.

Not until 1989, when the Voyager II space probe sent back photographs during a flyby, did we learn that Neptune was blue. Interestingly, this fits nicely with the Neptune (or Poseidon) of classical mythology—god of rivers and springs, god of the sea.





Zooming In on Neptune

1. Choose the Planets command from the Location menu. In the dialog box, select Neptune from the Planets list and choose OK. You are transported to Neptune, in an orbit 97,200 kilometers from the core of the planet. (This distance is 4 planetary radii.)
2. Click the Zoom plus sign button or press the plus sign key several times. The more you zoom in, the closer Neptune seems to become.
3. Click the Zoom minus sign button or press the minus sign key to reduce your zoom factor.
4. Press the zero key on the main keyboard. Immediately the zoom factor returns to 2.00.

Although Neptune seems to become closer when you zoom in, your orbital distance of 4 radii does not change. (A "radius" is a handy unit of measure for orbital distances. It equals half the diameter of an object; the radius of a planet is the distance from its center to its surface. When you use the Location menu to travel to a new destination, Space Simulator places you approximately 4 radii from the object

you've selected. The larger the object, the farther away you'll be—a useful feature because, although arriving 2 kilometers from the center of Ring Station 1 gives you plenty of maneuvering room, arriving 2 kilometers from the center of Neptune can ruin your day.)

Fun with the Location Button

As you discovered in Chapter 2, you can choose the Location button (by clicking it or by pressing Alt-C) to shift your viewing position from inside the cockpit to a position inside a chase craft, looking down on your own ship. Choose the button a second time to see Assigned view; choose it a third time to restore Cockpit view. In other words, the Location button is like a three-position switch that cycles your view from Cockpit to Chase to Assigned and then back to Cockpit. (You can also cycle through these views by pressing the single-key shortcut S.)

Getting the Most from Chase View

The allure of Chase view perhaps lies somewhere between vanity and curiosity: It's wonderful to be able to see yourself flying through space, and it's also interesting to see clearly how your ship responds to various controls. In addition, you can enhance this view in some sweet ways, such as adjusting the distance of the view and changing the view position or the perspective.

BEHIND THE SCENES
By Any Other Name

The name of the Location button is actually shorthand for the term View Location. The word View was omitted simply because the instrument panel doesn't contain enough room for it when displayed in VGA mode. (All you lucky dogs with SVGA displays can just shake your head at all the blank space that could have accommodated more descriptive labels on your instrument panels—although your eyes will more likely be focused on the stunning things you see above the instrument panel as you take in the sights of space.)

For the same reason, the label Chase that appears on the Location button when you are in Chase view is shorthand for Chase Craft, a term familiar to anyone who's ever played around with Flight Simulator. And the Direction button should more properly be called View Direction—or, perhaps more intuitively, Viewing Method.

♦ ♦ ♦

Adjusting the Chase Craft Distance

To shorten the distance between the chase craft and your own spacecraft, press Alt-plus sign key (on the main keyboard). Notice how the size of your spacecraft increases each time you press this key combination. Press Alt-minus sign key to increase the distance between the two crafts (decreasing the size of your ship).

You can also use a menu command and its dialog box to adjust the distance:

1. Choose the View Controls command from the Window menu.
2. In the View Controls dialog box, move to the Chase Craft Distance slider bar, which appears near the middle of the dialog box.
3. Click at a different position along the Chase Craft Distance slider bar, or type a number from 1 through 9 (on the main keyboard). When you've adjusted the setting, choose OK.



It takes a bit longer to set the chase craft distance from the View Controls dialog box, but if the dialog box is already on the screen for another reason, it's easy to use the slider bar.

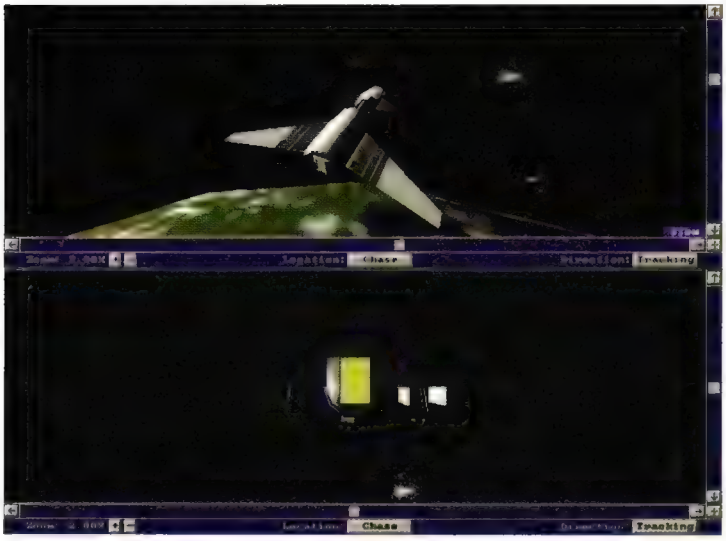


TECH TIP

Adjusting the distance between the two crafts in Chase view is a good way to change the size of your ship (or whatever object you're tracking) in your cockpit window. You can also make an object look larger or smaller by using the zoom feature, but remember that changing the zoom factor affects everything within your view, not just the ship or other tracking object.

Changing Chase View Position

Press Alt-right arrow key or Alt-left arrow key to change the horizontal position of the chase craft relative to your spacecraft. To adjust the vertical placement of the chase craft relative to your ship, press Alt-up arrow key or Alt-down arrow key. You can also use the alternative methods of clicking anywhere along the horizontal or vertical panning bar, clicking the arrow at either end of a panning bar, or dragging the panning bar's location tab.



In the bottom window, the chase craft is directly behind your ship, with standard panning bar settings; in the top window, the chase craft moves up and slightly to the right, for a more enjoyable view.



TECH TIP

When you switch from relative perspective to absolute perspective, you might need to adjust the panning bars to keep the same background in view. For example, when you shift to absolute perspective in the FLIGHT situation, Earth and Ring Station 1 disappear. To see them again, press Shift-keypad 6 to power pan to the right. To return to relative perspective, press B and then press Alt-keypad 5 to recenter your view.

Changing Chase Craft Perspective

When you are using Chase view, you can choose one of two chase craft perspectives: relative or absolute. These two perspectives differ quite a bit, and each has its own merits.

Relative chase craft perspective means that the chase craft remains locked in place relative to your spaceship. You can think of the chase craft as a camera attached to your ship. No matter how you shift your view using the panning bars, you'll always see your ship from the same relative perspective.

Absolute chase craft perspective provides probably the most natural form of Chase view. In this case, the chase craft remains in an absolute position, meaning that if you turn your own spacecraft, you can actually see it turning from the perspective of the chase craft, which does not turn correspondingly.

Space Simulator's default setting is relative chase craft perspective, although I find the absolute perspective more to my liking. When you are flying long distances, using relative perspective helps you keep your ship properly oriented toward your destination. But when it comes to close maneuvers, such as docking with a space station or flying the manned maneuvering unit, absolute perspective is more fun because you can see your craft turning rather than having the sky turn around the ship.

Here's how to change the chase craft perspective:

1. Choose the View Controls command from the Window menu.
2. In the View Controls dialog box, locate the Chase Craft Perspective section.
3. Select the Absolute option button. (If you are already using absolute perspective, select the Relative option button. The option button that is filled in shows the current setting.) Then choose OK.

As a shortcut, you can bypass the dialog box and press the B key to immediately toggle between absolute perspective and relative perspective.

MISSION: Cycling Between Views While Orbiting Callisto

Cycling between Cockpit view and Chase view is an enjoyable way to fly as well as a useful tool for performing close maneuvers. In this mission, let's simply zap ourselves over to Jupiter's moon Callisto to see how the ship looks against this moon in Chase view; in our next mission, we'll try shifting views during a close maneuver.

Cycling Between Cockpit View and Chase View

1. Choose the Moons command from the Location menu. In the dialog box, select Callisto from the list. If the Update Tracking Object check box is turned on, turn it off, and then choose OK. You are now in orbit 9,600 kilometers from the core of Callisto.
2. Choose the Location button (or press the S key) to cycle to Chase view.
3. Press Alt-plus sign key and Alt-minus sign key to adjust the distance of the chase craft from your ship. Different settings provide different effects. For example, you might enjoy seeing a small image of your spacecraft against a large celestial object.
4. Press Alt-left or right arrow key and Alt-up or down arrow key to adjust the location of the chase craft in relation to your spacecraft.



TECH TIP

When you are in Chase view and use the Location menu to move to a new destination, you'll lose sight of your spacecraft if the Update Tracking Object check box is turned on. If you can't find your ship in Chase view, press the T key to display the Select Tracking Object dialog box. Then select your ship as the new tracking object.

5. Press the B key to toggle your chase craft perspective between absolute and relative. Try maneuvering your spacecraft in each perspective to get a better feel for what each one offers.
6. Choose the Location button to cycle back to Cockpit view, once again looking out your front window.

Getting the Most from Assigned View

Assigned view is terrific for performing landings, dockings, and other close maneuvers. Whenever you plan to be working close to another object, you can choose that object as the location of your new Assigned view. Assigned view is like having a portable video camera that you can place in any location to watch any object from that location.

You can also use Assigned view to monitor an object other than your spacecraft, such as your destination planet or an astronomical vista that you want to keep in sight. You'll probably use Assigned view less often than Cockpit or Chase view simply because once your spacecraft gets very far from the Assigned view location, you will no longer be able to see your ship. For example, placing your "camera" on Ring Station 1 allows you to watch your ship fly past. But if you then head for the moon, you'll soon be out of sight of Ring Station 1, and the Assigned view becomes rather boring.

BEHIND THE SCENES
The Joy of Programming in Assembly Language

Charles Guy and his colleagues worked in assembly language as they created Space Simulator. Assembly language differs from programming languages such as Pascal and C in that there are no layers between the programmer and the actual functioning of the chip. Programmers turn to assembly-language code when they need blinding speed and elegant efficiency.

"Assembly can be very tedious, but the results are rewarding," Guy says. "It gives you much more control. I'm so used to machine language that I don't even like the idea of the other languages anymore. They just seem too indirect."

Like some other programmers, Guy finds beauty and escape in the purity of computer code. "So much of daily life can be so petty, and programming is a great escape from that. It is a great way to clear your mind, and it places me in a better frame of reference for dealing with people."

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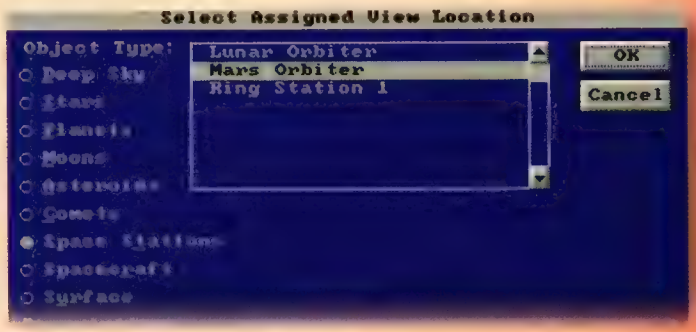
MISSION: Close Maneuvers at the Mars Orbiter

Space stations are a great place to see the value of Assigned view. For this mission, we'll use the Location menu to visit a space station orbiting more than 3,300 kilometers above the surface of Mars. As we close in on the space station, we'll cycle through all three views.

Cycling Between Views at the Mars Orbiter

1. Choose the View Controls command from the Window menu. In the View Controls dialog box, choose the Assigned View button.
2. You'll see the Select Assigned View Location dialog box. From the Object Type list, select the Space Stations option button. Notice the various other categories of objects, such as Deep Sky, Planets, or Moons, that you can select for other missions.
3. The names of all the available space stations appear in the list box. Select Mars Orbiter from the list and choose OK.
4. When the View Controls dialog box reappears, notice that Assigned view is now set for the Mars Orbiter. Choose OK to close this dialog box.
5. Choose the Space Stations command from the Location menu. In the dialog box, select Mars Orbiter from the list and choose OK. This moves your spaceship to the location of the Assigned view you just chose. You are now located 1.7 kilometers from the Mars Orbiter.
6. Choose the Location button to cycle to Assigned view.
7. Click the Zoom plus sign button or press the plus sign key to zoom in on your spacecraft if you can't immediately see it from Assigned view.
8. Flying either in slew control or in flight control (depending on your fancy), apply thrust and start to move in on the Mars Orbiter. As you fly toward the orbiter, cycle between Cockpit, Chase, and Assigned views to watch your maneuvers from these three vantage points. When you move closer, you can reduce the amount of zoom used from Assigned view. For a larger view, choose the Hide Instrument Panel command from the Window menu.

   Try to fly completely around the orbiter, changing the view as you travel. See how close you can come to the orbiter without colliding.





TECH TIP

You can press the A key to display the Select Assigned View Location dialog box without choosing the View Controls command.

SPACECRAFT CLOSEUP

A starship powered by nuclear fusion, the Galactic Explorer provides a maximum thrust of 4 Gs. It carries enough fuel to last 317 years at maximum acceleration, although coasting through the vacuum of space can help to stretch the fuel supply for millennia of exploration. If you ever run out of fuel in this ship, you can replenish the tanks by docking with a space station. (Or you can "cheat" by choosing the Spacecraft command from the Flight menu and simply reselecting the ship.)



Seen from the chase craft, the Galactic Explorer approaches the Mars Orbiter.



You can also watch the spacecraft from the vantage point of the space station.



The Direction Button: Panning and Tracking

The Direction button allows you to control a powerful viewing feature: the ability to see the world in either a panning mode or a tracking mode.

As you've already seen, *panning* is the term we use for simply looking around. Panning, which is Space Simulator's default setting, lets you look out your cockpit window and see whatever you want.

Tracking is the viewing method to use when you want to keep a particular object as your focus. Tracking is rather like having Space Simulator scroll the panning bars for you, to keep an object in view. For example, earlier you flew past Ring Station 1 and adjusted the horizontal panning bars to keep the station in view. With tracking, all you need to do is select Ring Station 1 as the tracking object, and Space Simulator keeps it in view.

You will probably find yourself shifting frequently between panning and tracking. To toggle between these two modes, just choose the Direction button or press the D key.

To get the most from tracking, you will want to assign your own tracking object. Let's return to Earth orbit to try this out. Choose the Planets command from the Location menu, select Earth in the dialog box, and then choose OK.

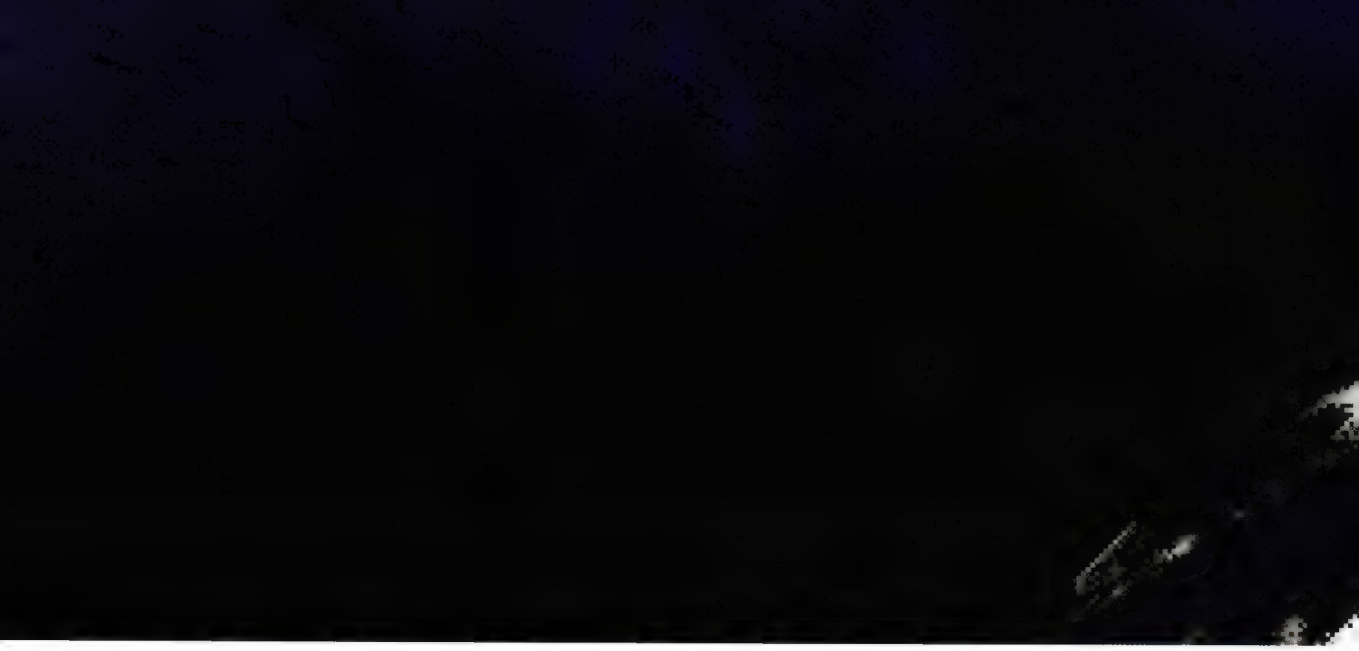


TECH TIP

You can press the T key to display the Select Tracking Object dialog box without choosing the View Controls command.

Choosing a Tracking Object

1. Choose the View Controls command from the Window menu. In the View Controls dialog box, choose the Tracking Object button.
2. You'll see the Select Tracking Object dialog box. From the Object Type list, select the Planets option button.
3. The names of all the available planets appear in the list box. Select Earth from the list and choose OK.
4. When the View Controls dialog box reappears, the tracking object is now changed to Earth. Choose OK.

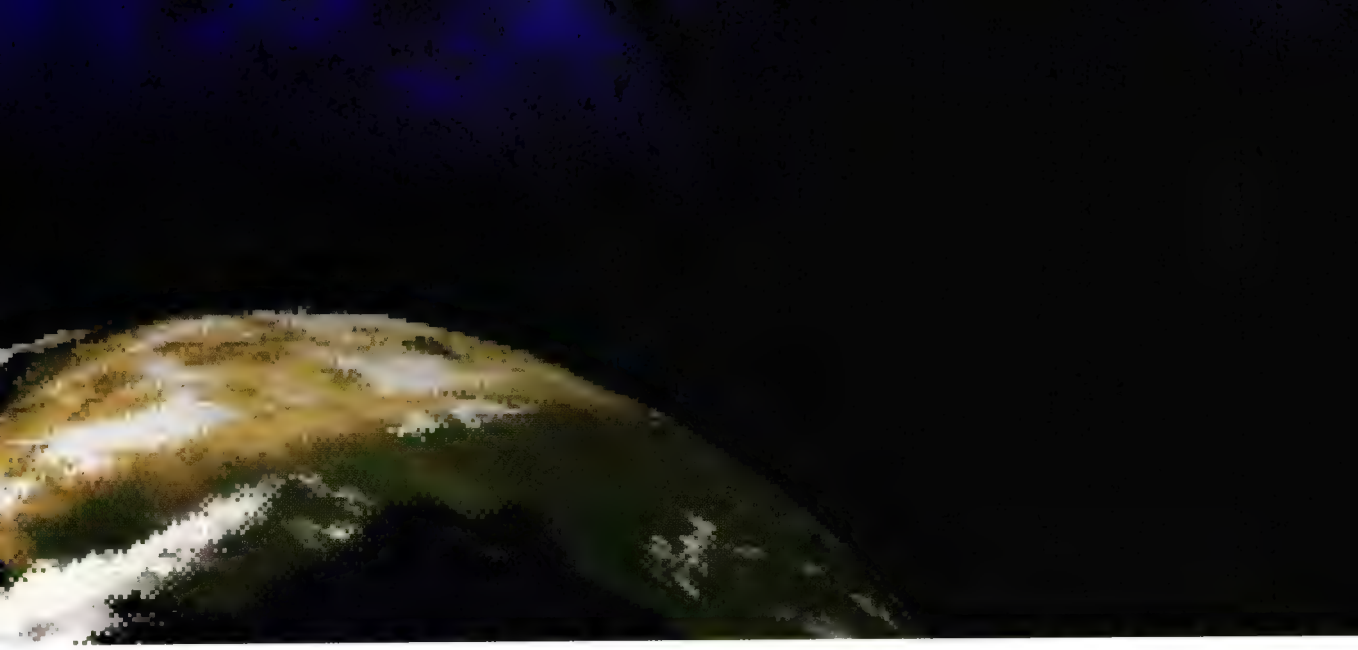


MISSION: Tracking Earth on a Flyby

To appreciate the difference between panning and tracking, let's do a planetary flyby using each viewing method.

Doing an Earth Flyby with Panning and Tracking

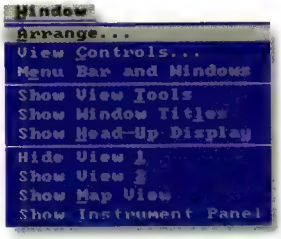
1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT, and then choose OK to move into Earth orbit.
2. Choose the View Controls command from the Window menu. In the View Controls dialog box, choose the Tracking Object button.
3. The Select Tracking Object dialog box is displayed. From the Object Type list, select the Planets option button. Select Earth from the list, and then choose OK to return to the View Controls dialog box.
4. In the View Controls dialog box, the tracking object is now set for Earth. Choose OK to close this dialog box.
5. Choose the Direction button (or press D) to toggle to panning. Using this setting, you will not see Earth once you fly past it.
6. Press Y to turn on slew control, which will make it quicker and easier to fly past Earth.
7. To give your ship plenty of velocity, press the keypad plus sign key 20 times.
8. Press the down arrow key to steer your ship away from the planet and avoid a collision.
9. Press Alt-down arrow key to adjust your view so that you can see Earth disappear beneath you. When you are panning, you must manually adjust your view to keep Earth in sight.



10. Click the Reset button, or drag the location tab back to the center of the vertical panning bar.
11. Repeat the steps above, but this time choose the Direction button to switch to tracking mode. When you are tracking, you do not need to pan manually. Earth remains in view as your tracking object, even after you've flown past it.

Taking a Closer Look at the Window Menu

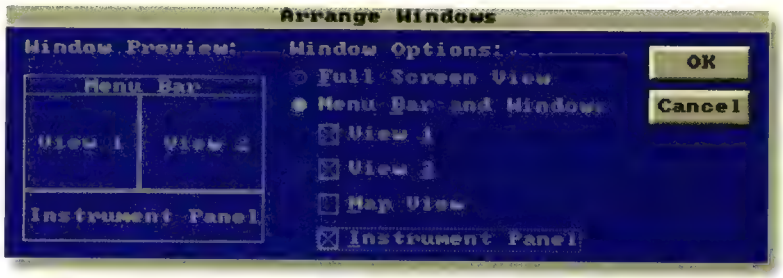
You'll use the Window menu frequently during your flights. Many of its commands allow you to arrange various views on the screen. This ability means that you can view more than one activity at a time, and it also means that you can turn on or off labeling and other features to provide either more information or more viewing room, depending on your purpose.



Let's first take a look at the Arrange command.

Organizing Your Screen with the Arrange Command

With the Arrange command and the Arrange Windows dialog box, the main window of your spacecraft's cockpit can become sophisticated and multitasking. You can design your own layout of views, while getting a sneak preview of what your screen will look like.



The Arrange Windows dialog box lets you choose Full Screen view, which provides a view of space and hides everything else. Or you can choose the Menu Bar And Windows option and then turn on various check boxes to display View 1, View 2, Map view, the instrument panel, or any combination of these elements. The Window Preview diagram lets you see in advance how the elements will be arranged on your screen; if you don't like the arrangement, you can change it before closing the dialog box.



TECH TIP

When you shift to Full Screen view and the menu bar disappears, there's no need to panic. Just place your mouse pointer anywhere along the top left of the screen, and click to return the menu bar. You can also restore the menu bar in Full Screen view by pressing the Alt key.

Choosing Full Screen View

1. Choose the Arrange command from the Window menu.
2. In the Arrange Windows dialog box, select the Full Screen View option button and choose OK.

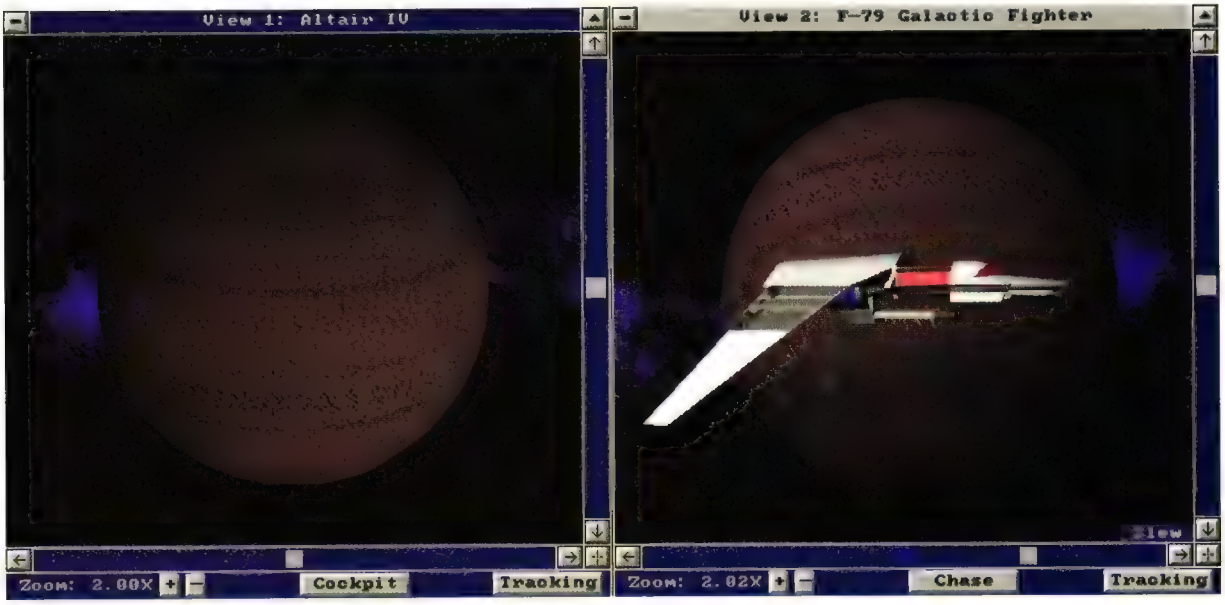
   There you are: Your entire cockpit window is now given over to one huge view of space.

Alternatively, you can use either of two shortcuts to display Full Screen view. Pressing the W key toggles Full Screen view on and off: Press this key once, and you move to Full Screen view; press it again, and you return to your previous view settings. You can also shift directly to Full Screen view by choosing the Full Screen View command from the Window menu. (This command does not display a dialog box.)

Displaying View 1 and View 2

1. Choose the Arrange command from the Window menu.
2. In the Arrange Windows dialog box, select the Menu Bar And Windows option button. The initial Window Preview diagram shows a layout that includes the menu bar, View 1, and the instrument panel.

3. In the Window Options list, select the View 2 check box to turn on this option. The Window Preview diagram now shows View 1 and View 2 side by side, with the menu bar above and the instrument panel beneath.
4. Select the Instrument Panel check box to turn it off. The Window Preview diagram now shows the menu bar, View 1, and View 2 stacked vertically.
5. Select the Instrument Panel check box again to turn it back on, and then choose OK. When the dialog box closes, your screen will display View 1 and View 2 side by side above the instrument panel.
6. Again choose the Arrange command from the Window menu. In the dialog box, turn off the Instrument Panel check box and choose OK. Now your screen shows both View 1 and View 2 but no instrument panel.



Open the Arrange Windows dialog box again, and experiment with the various options, including the one that displays Map view, which we'll discuss in the last section of this chapter. Notice that when you display two or more windows and then turn off one of them, the screen real estate is taken over by the remaining windows.



TECH TIP

To enjoy the beauty of Full Screen view without hiding your important view tools, choose the Hide Instrument Panel command from the Window menu.

Using the Show/Hide Toggle Commands

The Hide View 1, Show View 2, Show Map View, and Show Instrument Panel commands on the Window menu are toggles. For example, if you choose Hide View 1, View 1 disappears from your screen. The next time you open the Window menu, the command name has changed to Show View 1. You can choose this command to turn View 1 back on.

This set of commands provides a convenient alternative to the Arrange Windows dialog box. The toggle commands are handy for quickly displaying or hiding a view or the instrument panel when you know exactly what you want to see on the screen and don't need to experiment with a preview. There are also four shortcut keys on the main keyboard for displaying or activating (but not for hiding) these screen elements: Press the 1 key to display View 1 (or to activate it, if it is already visible), and press 2 for View 2. Press the M key for Map view and the I key for the instrument panel.

Another group of commands on the Window menu includes the Hide View Tools and the Hide Window Titles commands. These are most useful when you want as much viewing space as possible for seeing what's around you. Hide View Tools does away with the panning bars as well as the Zoom, Location, Direction, and Reset buttons. (When the panning bars are hidden, you can still pan by pressing Alt-up or down arrow key or Alt-right or left arrow key.) Choosing Hide Window Titles removes the title bars across the top of each window. After you choose these toggle commands, the command names are reset to Show View Tools and Show Window Titles.

This group of commands also includes the Show Head-Up Display command; for information about this feature, see "Using the Head-Up Display," in Chapter 7.

Customizing Your Views with View Controls

View Controls is one of the most important commands on the Window menu. With the View Controls dialog box, you can tweak precisely what you want to see and how you want to see it.



Across the top of the dialog box is the View Controls For Window box, in which you select the view window you want to customize during this visit to the dialog box: View 1, View 2, or Map View. To choose a vantage point for this window, select Cockpit, Chase Craft, or Assigned in the View Location section (the dialog box counterpart of the Location button on the view tools). If you are using Chase view, you can set either a relative or an absolute perspective in the Chase Craft Perspective section.

In the View Direction section, you choose either panning or tracking, as you can with the Direction button on the view tools. You're already familiar with the Assigned View button, the Chase Craft Distance slider bar, and the Tracking Object button. An additional feature is the Docking Port Camera check box; turn it on to have your Assigned view come from the camera located in the docking port of your ship.

To demonstrate how these various dialog box options can help you customize a view, we will customize first View 1 and then View 2. You can, of course, use any of the choices in these examples for either view. (For more information on Map view, see "Customizing Map View," later in this chapter.)



TECH TIP

When you set Assigned view for a space station and turn on the docking port camera, you can monitor your spacecraft's positioning as you line up with the docking port. Be sure to use panning rather than tracking so that you can see your ship move into view just as if you were looking through the docking port.

Customizing View 1

1. Choose the View Controls command from the Window menu. In the View Controls For Window section of the dialog box, select View 1 (if it is not already selected).
2. In the View Location section, select Chase Craft to have View 1 show your spaceship as it is seen from the chase craft.
3. Select Absolute in the Chase Craft Perspective section.
4. In the View Direction section, select Panning as your method of viewing.
5. Ignore the Assigned View button in the dialog box; for this example, you are using Chase view, not Assigned view.
6. On the Chase Craft Distance scale, set the distance to 3. (After you close the dialog box, you can change this setting again by pressing Alt-plus sign key or Alt-minus sign key.)
7. Ignore the Tracking Object button because you're using panning rather than tracking in this example.
8. Choose OK.

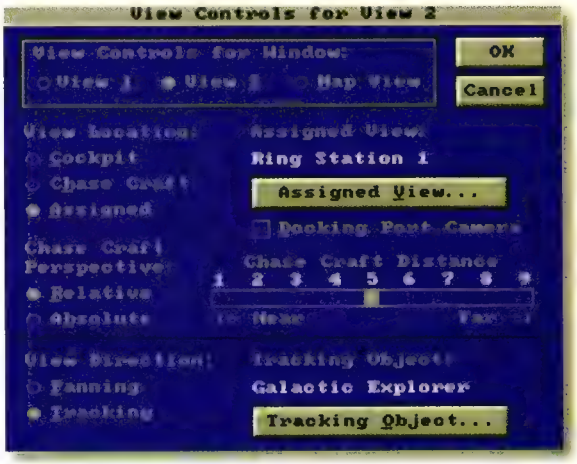
Now, after customizing View 1, you'll see yourself in Chase view, and you'll be able to see your craft turn and maneuver.

Customizing View 2

1. If View 2 is not already displayed on your screen, choose the Show View 2 command from the Window menu.
2. Choose the View Controls command from the Window menu. In the View Controls For Window section of the dialog box, select View 2. Notice that the dialog box's title bar is updated to View Controls For View 2.
3. In the View Location section, select Assigned. Because you're using Assigned view rather than Chase view, you can ignore the Chase Craft Perspective section.
4. In the View Direction section, select Tracking as your method of viewing.
5. Choose the Assigned View button.
6. In the Select Assigned View Location dialog box, select Space Stations from the Object Type list.
7. Select Ring Station 1 from the list of space station names and choose OK. Assigned view is now set for Ring Station 1.
8. In the View Controls dialog box, choose the Tracking Object button.
9. In the Select Tracking Object dialog box, select Spacecraft from the Object Type list to display the names of all the available spacecraft in the list box.
10. Select the name of your current spacecraft from the list and choose OK.
11. Choose OK to close the View Controls dialog box.

You've now customized View 2, with Assigned view set to track your spacecraft. Fly your ship up to the space station, watching your progress from the two views. You can press the S key to cycle either view to Cockpit as you home in on Ring Station 1.

The View Controls dialog box is a handy area for setting up and customizing your views. Of course, as you've seen, you can make many view adjustments without the dialog box, simply by using view tools such as the Location button, the Direction button, or keyboard shortcuts. But when you need to change several settings at the same time, the View Controls dialog box can be an efficient method.



Customizing Map View

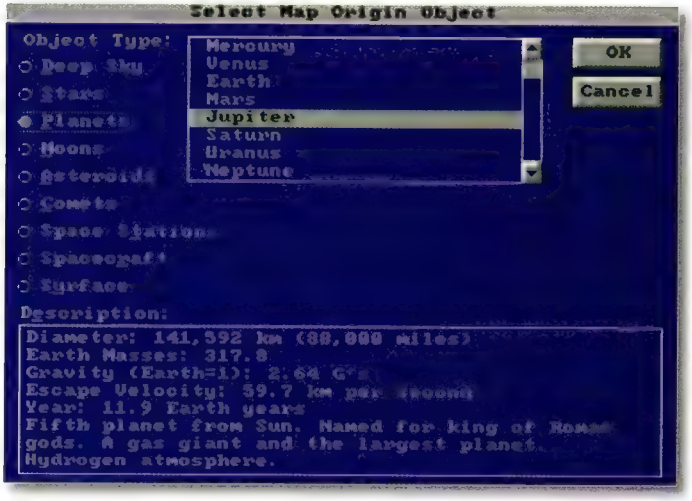
Because space is so vast, Space Simulator provides an excellent map system to prevent you from getting lost—or at least to help you find your way back once you become lost. When you open the View Controls dialog box and select Map View in the View Controls For Window section, a new dialog box is displayed.



In this new dialog box, called View Controls For Map View, you can choose what objects you want to see on your map and what object should appear at the center (the origin) of the map. With the Show On Map list, you indicate whether you want only planets and moons to be shown, for example, or whether you want to see stars, comets, asteroids, any combination of the listed objects, or even all the objects.

When you choose the Map Origin button, you'll move to the Select Map Origin Object dialog box, which is shown on the next page.

In the Select Map Origin Object dialog box, you can select an object type, such as stars, planets, or moons, and then select the specific object you want to appear at the center of your map. For example, you could first select Planets and then select Jupiter to produce a map that has Jupiter at its center, with the planet's moons orbiting. Or you could select the Sun, Earth, or an obscure asteroid as the map origin.



A third critical element in customizing Map view appears on the Options menu. If you want to see the names of the objects that appear on your map, choose the Preferences command from this menu. From the dialog box's Category list, select the Labels option button. Then select the Map Objects check box and choose OK.



Map view showing the orbits of Jupiter's inner moons.

ASTRONOMICALLY SPEAKING
Bubbles of Eternity

Harvard astronomer Margaret Geller has spent more than a decade studying the location of galaxies to create a three-dimensional map of the universe. Although Geller and colleagues around the world have now mapped more than 80,000 galaxies, this is but a glimpse of the sky, as billions of galaxies exist within the visible universe.

But the mapping effort has already yielded a big surprise: Galaxies appear to be situated as if they are clinging to the surface of unimaginably huge "bubbles" in space—Geller suggests the image of an expanse of frothing soap bubbles. These bubbles, however, are empty voids as large as 150 million light-years in diameter, coated with galaxies that each consist of hundreds of billions of stars.

Margaret Geller is spending her life trying to discern patterns in the cosmic collection of galactic bubbles. In an interview published in the *Seattle Times*, she said she was intrigued by two questions at the beginning of her career: "What does the universe look like? Where did we come from?" As she continues to answer the first of those questions, perhaps an answer to the second will emerge.




5
PILOTING WITH PRECISION
it's pushing midnight, and I'm listening to a favorite CD of Indian classical music—haunting evening ragas, most mysterious. I'm looking through Chase view as Space Station Freedom, a space shuttle, and the heroic manned maneuvering unit float in the gentle stillness of space, while the cloud whites and ocean blues of Earth rotate by, some 400 kilometers below.
I've flown the MMU right up next to the space station to get a feeling for the size of the cylinders used to construct the station. When you're trying to understand the scale of structures in space, the human-sized MMU is a good yardstick.



SPACECRAFT CLOSEUP

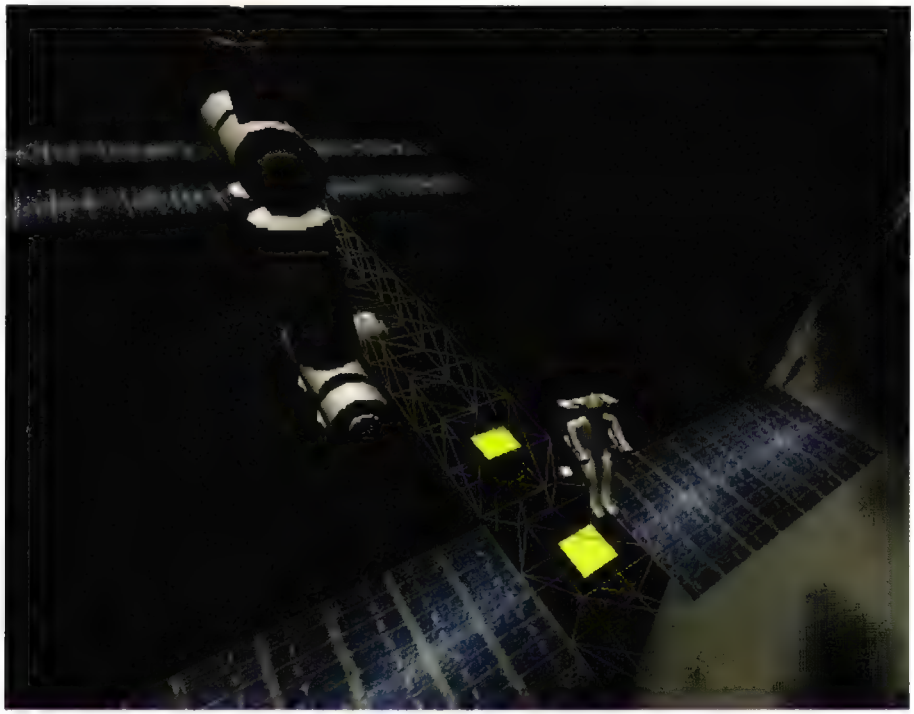
The manned maneuvering unit, which looks a lot like an oversized backpack, is the utility and repair vehicle of space development. To launch the MMU and then tour your ship's exterior or inspect the outside of a space station, choose the Space Walk command from the Flight menu or press Shift-W.

The MMU is propelled by small nitrogen thrusters, which work on the same principle as a balloon that you've inflated and then released—although the MMU is more controllable! Watch your fuel gauge; the MMU carries only 50 kilograms of nitrogen.

There is something both nice and exciting about being up close to a space station—perhaps space is so vast that just being in close proximity to one of these structures provides a comfort. And when you're exploring the exterior of a ship or a station, especially when out in the MMU, the scale of the experience seems more human and alive. It is one thing to stare into unmoving stars while making interplanetary or interstellar passages; it is quite another to find yourself approaching a radar dish too fast or gliding just above the glowing blue spread of solar panels.

The Beauty Is in the Control

Now it's even closer to midnight, and I'm experiencing some of the most involving minutes I've yet discovered within Space Simulator. While flying in the MMU, inspecting the girder works of Space Station Freedom, I position myself so that by applying thrust of just a fraction of a meter per second and by using slew control and Chase view, I can watch my MMU-self slowly glide along the entire length of the space station.



The Sun's light is in high contrast as the shadowed MMU makes the long traverse along the girders of Space Station Freedom. After 3 minutes of flight, I come upon the cylindrical chambers that provide Freedom's living quarters and storage, gradually move by them, and then continue onward.

Perhaps it's just the hour of night, or maybe it's the stark lighting from the position of the Sun, but the slow progression of the MMU along the girder structure imparts a sense not only of being there but also of being rather lonely while making this long, slow inspection of the space station. And then, 4 minutes into this voyage, the sunlight shifts, and the MMU becomes just a black shape floating along the dimly lit girders. When finally I reach the end, there's a feeling of completion. It's all been quite exciting in an existential way.

Fortunately, at the beginning of the adventure, I had opened the Options menu and chosen the Save Situation command. Now I play the situation back, using different settings of the panning bars to see my MMU-self from different perspectives. In every way I play it back, the incredible sense of adventure returns. Close-encounter adventures such as this make precision piloting a joy; the beauty is in the control.



TECH TIP

The easy way to immediately cancel all fine thrust (or any other type of thrust) is to press F5 (or the Home key). You'll also frequently use the F4 key, which cuts all velocity, when you are precision piloting.

Using the Fine Thrust Gauge

A good place to start learning about precision piloting is the instrument panel's fine thrust gauge, a visual reference for how much thrust you have applied and in which direction. Especially when you are using flight control, the fine thrust gauge is the heart and soul of your precision piloting.

Up to now, you've used the main engines of your spacecraft to move from point A to point B. When you're maneuvering close to an object such as a space station, however, the main engines are a little like blunt tools. This is when your fine thrusters come in handy. Unlike the main engines, which provide only forward thrust, the fine thrusters can move your spacecraft directly up, down, left, right, forward, or backward—all without changing its attitude.

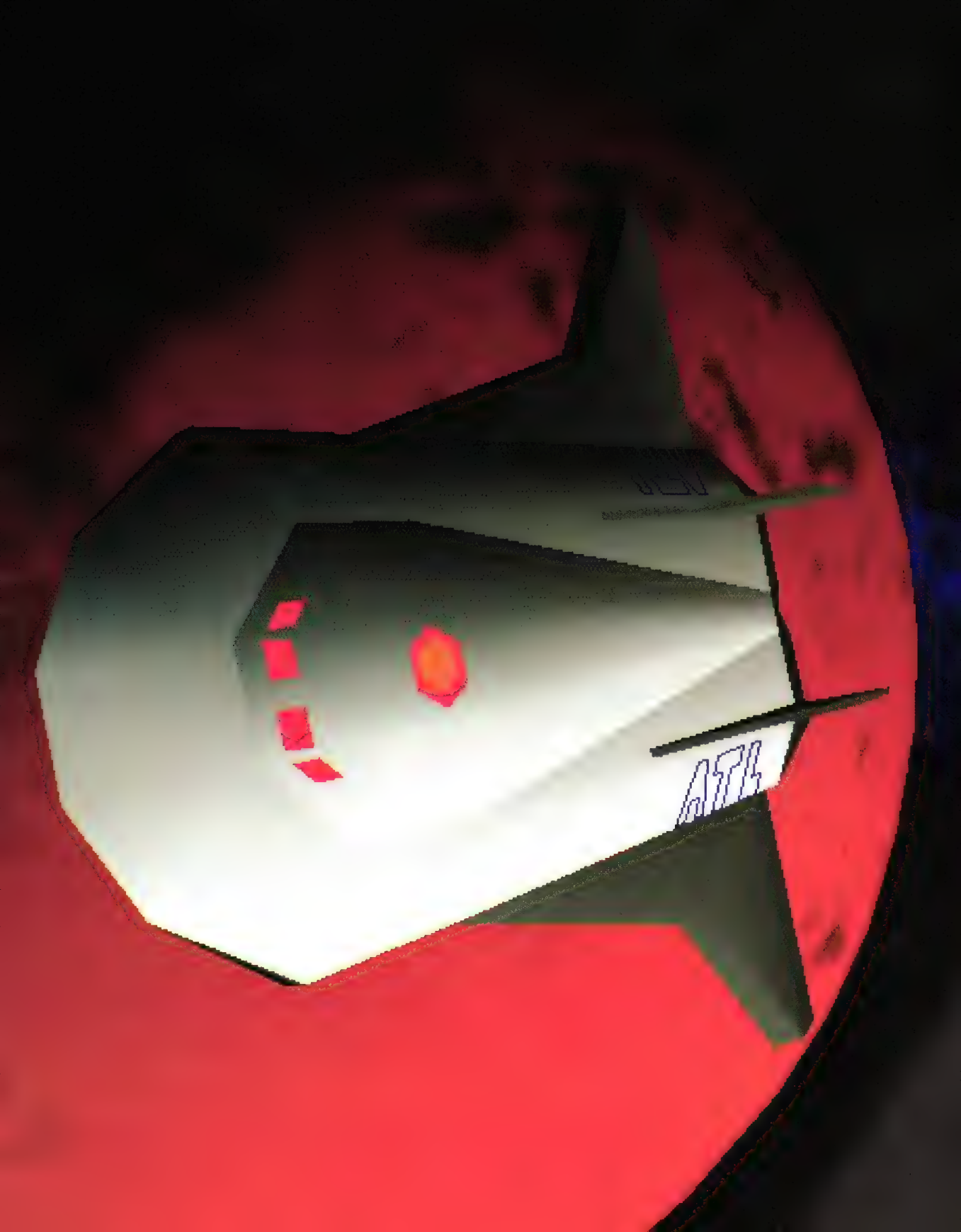
To take a closer look at the fine thrust gauge, let's return to the familiar FLIGHT situation. Choose the Open Situation command from the Options menu, select FLIGHT in the dialog box, and then choose OK.



Forward fine thrust



Backward fine thrust


ATL

Playing with Forward and Backward Fine Thrust

1. Choose the Location button to cycle from Cockpit view to Chase view so that you can see all the precision moves you make with your spacecraft.
2. Choose the Spacecraft command from the Flight menu. In the dialog box, select All Terrain Lander and choose OK. You are now flying the ATL. Unlike some of the other spacecraft, the ATL has a docking port located on the ship's topside rather than on its bottomside or its nose, making it easier to use when you are learning to dock.
3. Choose the reference display on the instrument panel. In the Select Reference Object dialog box, select the Space Stations option button. Then select Ring Station 1 from the list and choose OK. The instrument panel's reference information is now updated for Ring Station 1, your new reference object. The display shows your distance from the ring station in terms of both the station's radius and your altitude (how far away you are, in either meters or kilometers).
4. Press the B key to shift your chase craft perspective from relative to absolute, which lets you observe the motion of your spacecraft in the most natural fashion.
5. Press Shift-keypad 6 to place the chase craft directly behind the ATL.
6. Notice that your velocity is 0, indicating that you have no motion in relation to Ring Station 1. If your velocity is not 0, press F5 to cut all thrust and F4 to cut all velocity.
7. Press Shift-keypad plus sign three times to apply forward fine thrust. The fine thrust gauge fills with yellow along the forward axis. Watch the yellow fill as you press Shift-keypad plus sign two more times. The velocity builds toward a few meters per second, and the reference display shows that your spacecraft is slowly nearing Ring Station 1.
8. Use the arrow keys to turn your spacecraft so that it is headed directly toward the space station. Remember that keypad 5 stops all rotation.
9. Press Shift-keypad plus sign several more times. The yellow fill expands as fine thrust increases in the forward direction. Continue toward the space station until you are within 1 kilometer. Note that when you apply fine thrust, the velocity continues to increase unless you are flying in slew control.
10. Press Shift-keypad minus sign several times until the yellow fill in the fine thrust gauge disappears. If you begin to see the yellow fill in the backward axis of the gauge (meaning that you've gone beyond removing forward thrust and have begun to exert backward thrust), cancel the backward thrust by pressing Shift-keypad plus sign. When the yellow fill disappears from the fine thrust gauge, you have canceled all fine thrust.
11. Now try applying some backward fine thrust by pressing Shift-keypad minus sign several times, until the fine thrust gauge displays some yellow fill in the backward axis. Notice the change in your velocity readout.
12. Using both forward and backward fine thrust, pilot yourself to within an altitude of 400 meters of Ring Station 1.



SPACECRAFT CLOSEUP

The All Terrain Lander is a small but sturdy craft. In it, you can land directly on planets and moons under difficult conditions—and its hovering capability makes it great for exploring. The ATL's range is far beyond that of the space shuttle, but it provides a more personalized size than the huge interstellar ships. Charles Guy once described it as "very Miata-ish": fast, highly maneuverable, and simply fun.

To fly the ATL, select All Terrain Lander in the Spacecraft dialog box. You can also launch the ATL by choosing the Deploy Lander command from the Flight menu (or pressing Shift-D). The Retract Lander command on the same menu (or pressing Shift-D again) brings the ATL back home to the mother ship.

Playing with Upward and Downward Fine Thrust

You use the thrusters that are vertically mounted on your spacecraft to create upward and downward fine thrust. Applying upward fine thrust moves your spacecraft directly up along the craft's vertical axis, without altering its attitude; applying downward thrust moves the ship directly down in a similar fashion. Using fine thrust offers far greater precision than trying to adjust your position by using your main thrusters and then pitching up or down.

1. Press the PgDn key three or four times. The yellow fill extends along the downward axis of the fine thrust gauge.
2. Press the PgUp key several times. The first few keypresses will cancel your downward fine thrust, and you'll see the yellow fill recede from the downward axis of the gauge. As you continue to apply upward thrust by pressing PgUp, the yellow fill climbs in the gauge's upward axis. Watch as your spacecraft climbs in relation to Ring Station 1.
3. Press F5 to cancel all fine thrust. The yellow fill immediately disappears from the fine thrust gauge.
4. Reduce your velocity to 0 by pressing F4 .
5. Press the PgUp key four or five times. Continue applying upward fine thrust until your spacecraft is evenly aligned with the bottom of Ring Station 1. You will see the bright yellow lights from the living quarters aboard Ring Station 1 and the orange glow of the station's docking port.
6. Press PgDn to lessen the amount of upward fine thrust you are applying.
7. When your ship is directly below Ring Station 1, press F5 to cancel all thrust.
8. Press F4 to remove all residual velocity.



Upward fine thrust



Downward fine thrust



Left fine thrust



Right fine thrust

Continue to experiment with upward and downward fine thrust, using the F5 and F4 keys to cancel thrust and velocity. Now combine rotation with forward and backward fine thrust to see how close you can bring your spacecraft to the docking port of Ring Station 1. Monitor your distance from the station with the instrument panel's reference display. Using backward and forward fine thrust, place your ship beneath the station, lining up the ship's hexagonal docking port with the station's port. Then move your spacecraft closer to a docking position with upward and downward fine thrust. (Note that when you fly the Galactic Explorer, whose docking port is on the bottom of the ship, you must roll it upside down for docking and press PgDn to approach the station's docking port.)

Playing with Left and Right Fine Thrust

You can also use left and right fine thrust in precision piloting. To apply left fine thrust, press the keypad Ins key. As you continue to press this key, the yellow fill extends along the left side of the fine thrust gauge, and your spacecraft moves toward the left. Use the keypad Del key in a similar fashion to apply right fine thrust.

MISSION: Docking with Ring Station 1

Docking with Ring Station 1 is a classic adventure that requires precision piloting and the use of fine thrust. The goal is to match the orange hexagonal docking port of the space station with the docking port on your own spacecraft and then to ease your ship up against the station.

The precision necessary to make this match is determined by the skill level you select in the Skill Level Preferences dialog box. (Choose the Preferences command from the Options menu and select the Skill Level option button to display this dialog box.) When you set the skill level to Practice, you can dock simply by getting any part of your ship in contact with the docking port. Skill level settings of Intermediate and Advanced demand more exact alignment and greater control of velocity in making contact. For now, use the Practice skill level. (See "Skill Level Preferences," in Chapter 6, for more information about these three levels.)



TECH TIP

Most computer keyboards have two Ins keys and two Del keys. You can use either set to apply fine thrust, although it's easier to use the two keys at the bottom of the numeric keypad because their locations correspond to their functions: The Ins key, located to the left, controls left fine thrust; the Del key, on the right, controls right fine thrust.



TECH TIP

All the ships and space stations in Space Simulator use the same universal docking port system. When you want to find a docking port, just look for the orange hexagon.

An important part of precision piloting is being able to see exactly where you are and where you are going. Although you can appear to be perfectly aligned with a space station's docking port, you might find that you are actually way out of position when you check your location from a different perspective. Using the panning bars and tracking mode in Chase view to see your position relative to the space station from different angles can be a big help.

Using Tracking and the Panning Bars to Check Your Position

If you're still in the FLIGHT situation, positioned near Ring Station 1, you can move directly to the instructions that follow. If you are starting fresh, you'll need to reopen the FLIGHT situation, make the All Terrain Lander your spacecraft of the hour, and fly over to the bottom of the ring station, as you did earlier in the chapter. Then proceed to dock with Ring Station 1 as explained here.

1. Use the fine thrust controls, along with the F4 and F5 keys, to position your spacecraft near the Ring Station 1 docking port. Don't dock yet, however; continue to maintain some separation.
2. To view your ship in different ways, press Alt-right arrow key or click along the right side of the horizontal panning bar as many times as you like.
3. Press Alt-left arrow key or click along the left side of the horizontal panning bar, and then alternate between the left and right perspectives to see whether your ship still appears to be properly aligned.
4. Press Alt-up arrow key and Alt-down arrow key or click along the vertical panning bar, adjusting the perspective so that you can see what fine thrust adjustments you need to make.

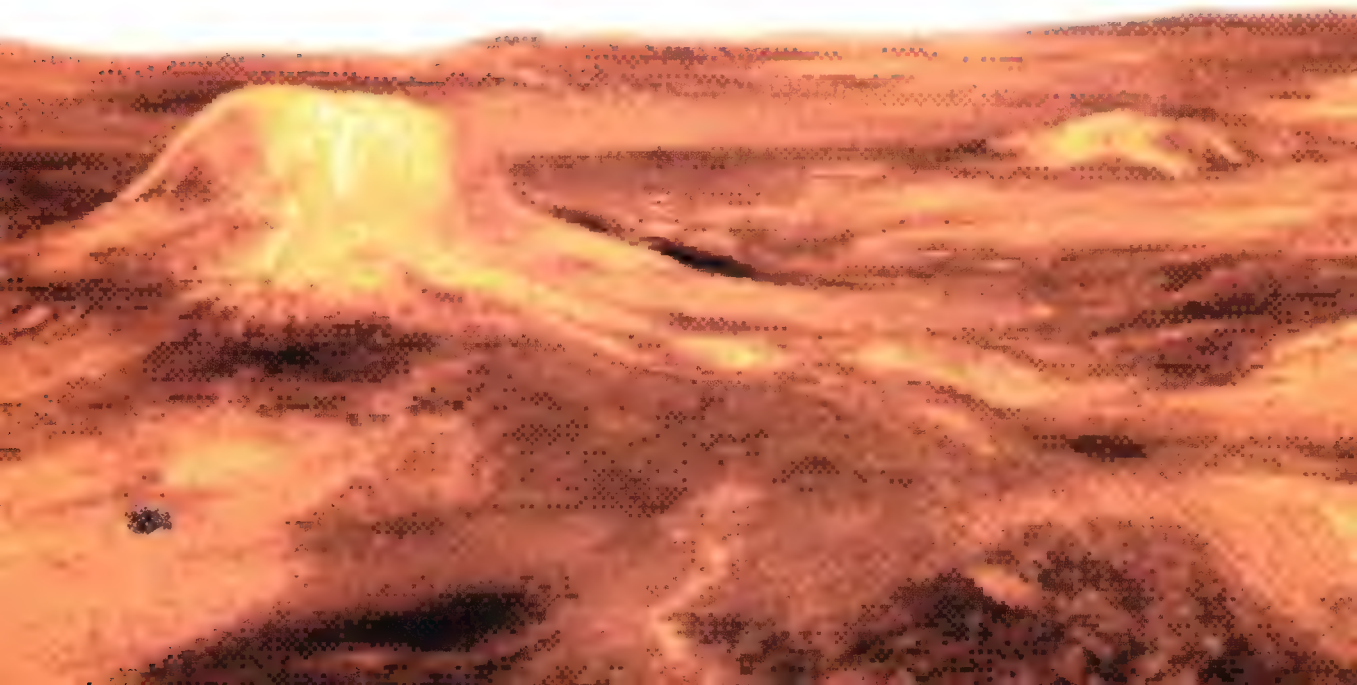
Continue to use the fine thrust controls and the F4 and F5 keys to nudge your spacecraft up against the docking port. You'll be able to tell when you've made contact because your spacecraft will take on the rotational speed and direction of the space station. You can verify that you have successfully docked by opening the Flight menu and checking the Undock command: Before docking, this command is grayed (unavailable); after docking, it becomes active.

BEHIND THE SCENES
Two Miles High

Just below the summit of the 7,500-foot Chelan butte, Charles Guy and I sat on a rocky ridge with the magnificent Columbia River down to our left and Lake Chelan to the right. We looked down toward the hot, dusty farmlands across the river and watched dust devils menace about. In the sky above were more than a dozen hang gliders, riding thermals and looking like colorful hawks.

Jon Solon, Space Simulator's program manager, was perched on the side of the hill, watching for signs of the wind in the trees and judging just the right moment to take his three running steps down the steep hillside. Before the fourth step could be made, he was airborne. Five minutes later he had found a column of rising air, and he radioed back to us that he had "climbed into an Otis elevator" and was ascending at 1,000 feet per minute.

It isn't surprising that someone who lands (and occasionally crash-lands) a hang glider would want to be able to land on planets. "Jon insisted that the user should be able to land on planets and then take off again," Charles said. "I explained all the problems associated with that, but because he insisted, we found a way."



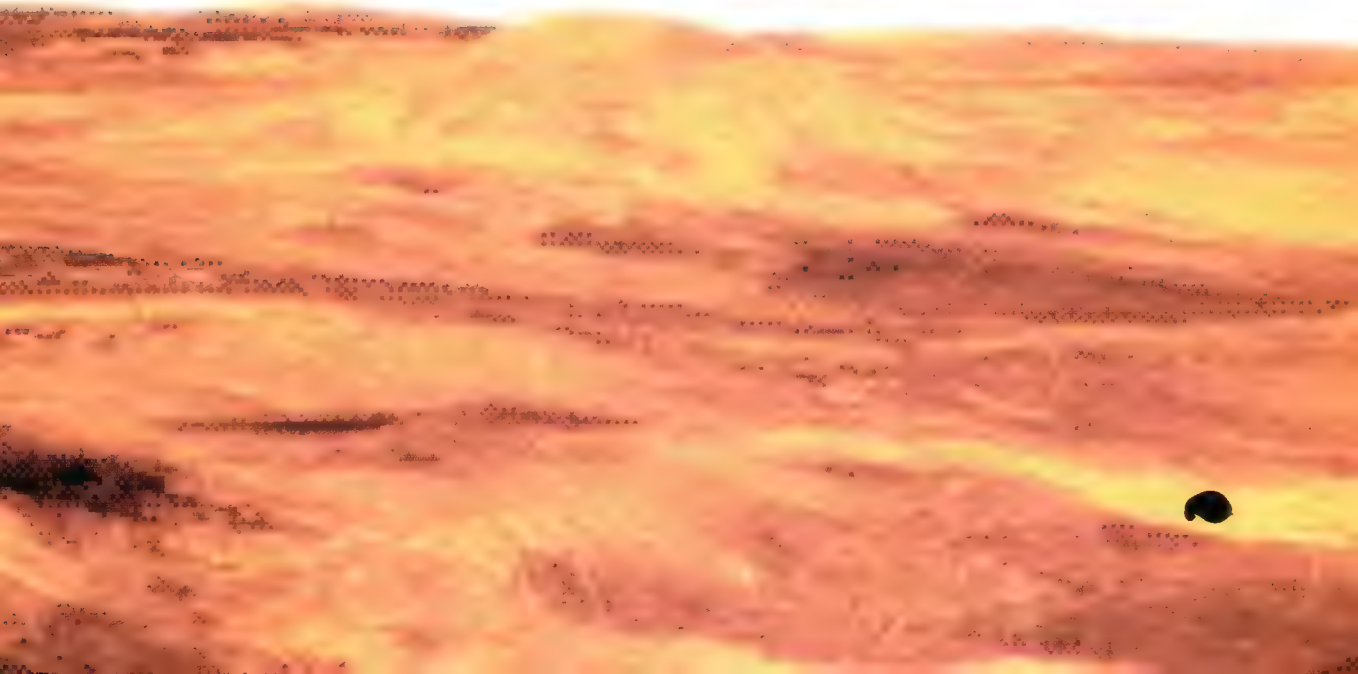
Flying the MMU with Fine Thrust

Flying around in the manned maneuvering unit is a great deal of fun. Although you can fly the MMU with standard thrust, the fine thrust controls will help you go exactly where you want without banging yourself up. And because you'll often want to use the MMU in close proximity to spacecraft and space stations, precision piloting is especially important.

MISSION: Flying the MMU to Ring Station 1

I've always found it a bit eerie to launch the MMU and leave my big ship behind. I've even felt a bit uneasy watching Jon Solon deploy his own MMU near one of Saturn's moons or fly his MMU out near the Sun. I almost wanted to shout, "Get that guy back on board the ship!"

So it was with some trepidation that I undertook my first MMU excursion to Ring Station 1. But of course it was exciting, like every MMU space walk I've taken since. Using the fine thrust controls, let's take this journey to Ring Station 1.





TECH TIP

After you have set your reference object, selected your spacecraft, and set other flight parameters, you can save these settings by creating a situation, in case you want to try the flight again. Choose the Save Situation command from the Options menu. In the dialog box, backspace over the existing filename and enter a new situation name such as MyMMU. Then add any notes in the Description box and choose OK. To start your trip again, simply choose the Open Situation command from the Options menu, select the situation name, and choose OK.

Preparing for the Flight

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and then choose OK to place yourself in Earth orbit near Ring Station 1.
2. Choose the reference display on the instrument panel. In the Select Reference Object dialog box, select the Space Stations option button. Then select Ring Station 1 and choose OK. Setting Ring Station 1 as your reference object will allow you to monitor the distance as you near the space station.
3. Choose the Spacecraft command from the Flight menu. In the dialog box, select Manned Maneuvering Unit and choose OK. You are now flying the MMU.
4. Choose the Location button to cycle to Chase view so that you can see the MMU.
5. To shorten the distance between the chase craft and your MMU (giving you a larger picture of your MMU-self), press Alt-plus sign key (on the main keyboard) five or six times. Press Alt-minus sign key (on the main keyboard) to increase the chase craft distance and see a smaller picture of yourself.
6. Press the B key to shift your chase craft perspective from relative to absolute so that you will be able to see the MMU turn while the space station and Earth remain in the same position.
7. Press Shift-keypad 6 or use the horizontal panning bar to bring Ring Station 1 back into view.

Making the Passage to Ring Station 1

Now that you are all set up for your passage in the MMU, use what you've just learned about the fine thrust controls to fly yourself over to Ring Station 1.

Because you are flying with flight control rather than slew control, your velocity will continue to increase slowly even if you press a fine thrust key only once. After applying all your forward fine thrust, watch the radial velocity readout, which will take nearly a minute to reach even 0.5 meter per second. The impatient can press F1 to advance the time scale, using F2 to slow the scale when necessary. Since the journey is just a bit over 2 kilometers, however, it is fun to travel in real time.

The easiest way to make the trip, of course, is simply to blast all the way over and then press F4 when you want to cut velocity. Another method is to use full fine thrust, which is achieved by pressing Shift-keypad plus sign 32 times. Monitor the distance to Ring Station 1 by watching the reference display on the instrument panel. When you reach the halfway point, approximately 1 kilometer from the space station, press F5 to cut thrust and then press Shift-keypad minus sign 32 times to provide full reverse fine thrust for the second half of the journey.

Depending on how well you steer, you should arrive in about 20 minutes with virtually no velocity remaining. Remember to press F5 to remove reverse thrust when you arrive, so that you don't begin backing away. Press F4 to cancel any remaining velocity.

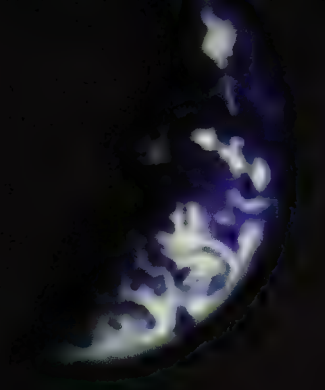
Using Fine Thrust in Slew Control

Fine thrust works nicely when you are flying with slew control. You'll find that you can benefit from the steady velocity that does not increase with time as it does in flight control. The fine thrust controls are the same whether you are using flight control or slew control, with one exception: Pressing Shift-keypad plus sign doesn't apply forward fine thrust in slew control; instead, you must press the keypad plus sign key alone (without Shift) for forward fine thrust.

There are also some other important differences. In slew control, each press of a fine thrust key causes a more rapid incremental increase in speed than a similar keypress in flight control. In flight control, each additional keypress increases fine thrust only slightly, whereas in slew control each additional keypress doubles the velocity. When you are slewing, you cannot travel as slowly as you can with flight control. But when you need to make extremely precise movements in slew control, you can give yourself more time to react by pressing F2 to slow the passage of time.

Because each keypress doubles your velocity in slew control, you can press any one of the fine thrust controls a number of times and achieve nearly the speed of light. You can move in the same directions that are possible with fine thrust in standard flight control—but you can do so at top speed. In flight control, you can apply large amounts of thrust with your ship's main engines and then use fine thrust to nudge the ship along for precise maneuvers. Using fine thrust in slew control provides the equivalent of six sets of main engines: one set pointing to the rear (as you would expect), one pointing forward, one left, one right, one up, and one down.

The Shift-keypad minus sign key combination is handy because it lets you back up your spacecraft without having to turn it around and then apply thrust with the main engines. When you are slewing, you can simply press Shift-keypad minus sign as many times as you like to achieve a desired speed. Let's give this a try now, by backing away from Earth at high speed.



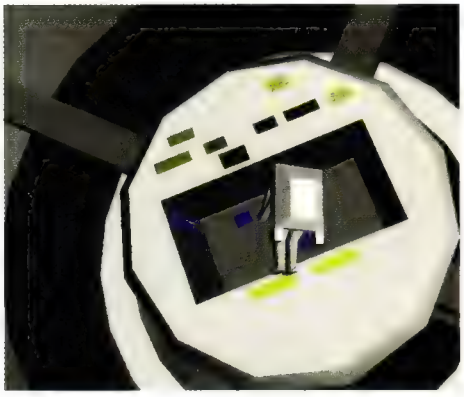
Backing Away from Earth, Fast!

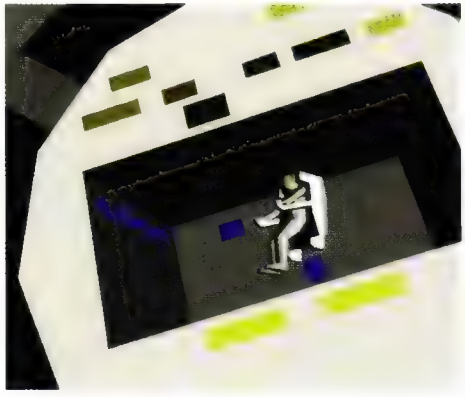
1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. Press the Y key to turn on slew control. (Or you can do it the formal way by choosing the Slew Control command from the Flight menu.)
3. Press Shift-keypad minus sign 24 times to achieve a velocity of more than 2,300 kilometers per second. You'll see a nice show as Earth fades into the background. Don't expect the stars to move, though. Even as fast and as far as you're moving, this speed is only a pittance relative to the great distances of the stars.
4. When you want to stop receding from Earth, press F5 to cut all thrust (and, because you're using slew control, all velocity). The F5 key is a great panic button to press when you discover that you're closing in on an object too fast.
5. Press keypad plus sign 24 times to achieve a forward velocity of 2,300-plus kilometers per second (or use a different number of keypresses to reach whatever speed you like).
6. When you near Earth, press F5—or at least steer away from the home planet to avoid a collision!



MISSION: Exploring the Cargo Bay

Here's a great little mission that was probably tried by everyone on the Space Simulator team at one time or another. Along the top surface of Ring Station 1 is a very enticing cargo bay. It's especially fun to fly into it with the MMU.





Flying the MMU into the Ring Station 1 Cargo Bay

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and then choose OK to once again begin an Earth orbit near Ring Station 1.
2. Choose the reference display on the instrument panel. In the Select Reference Object dialog box, select the Space Stations option button. Then select Ring Station 1 as your reference object and choose OK.
3. Use the Location button to cycle to Chase view so that you can watch yourself in action.
4. Choose the Spacecraft command from the Flight menu. In the dialog box, select Manned Maneuvering Unit and choose OK.
5. If you want to fly using slew control, press Y. You can fly this mission in either flight control or slew control, depending on your own preferences and piloting skills. (It's easier in slew control, but you might enjoy the challenge of flight control.)
6. Apply thrust, and use the yaw and pitch keys to fly to the top of Ring Station 1. Remember that you can press F5 to cut all thrust or F4 to cut all velocity if necessary. Monitor your progress by watching the distance shown in the reference display.
7. Position yourself over the entrance to the cargo bay, the rectangular opening centered across the top of Ring Station 1. Press PgUp or PgDn and use the keypad Ins and Del keys to fine-tune your positioning as you move above the opening of the cargo bay.



TECH TIP

The cargo bay of Ring Station 1 isn't always empty. Choose the Preferences command from the Options menu, and select the Rendering category in the dialog box. In the Shading section, select Faceted; in the Detail section, select Complex; and then choose OK. Now look inside the cargo bay again. (No, you can't fly it; its engine has been pulled for repairs. Sorry.)

Before you resume your mission, remember to reopen the Rendering Preferences dialog box and set the shading option back to Smooth for the best visual display.

8. Choose the Save Situation command from the Options menu (or press the semicolon key) to open the Save Situation dialog box. Backspace over the existing name in the File Name box, and then type the name you want to assign to this situation. (Don't worry—this action does not erase the situation whose name is being removed from the box.) You can also add descriptive information about the new situation in the Description box before choosing OK.

   It's a good idea to save the situation, just to be safe. Then, if you make a mistake and want to start over, you won't have to redo all your settings and fly to the ring station again.

9. To see a beautiful full-screen display, press the W key. If you need to use the instrument panel for precision piloting, press this toggle key again to leave Full Screen view and restore the instrument panel information.

10. Press Alt-left or right arrow key and Alt-up or down arrow key (or click along the panning bars) to see your position in relation to Ring Station 1 and the cargo bay from different perspectives.

11. Choose the Save Situation command from the Options menu or press the semicolon key, and then save the situation.

    During precision piloting, it's helpful to save the situation frequently to update it. You can update an existing situation simply by choosing OK in the Save Situation dialog box. If you want to save a series of situations, you can give each individual save its own name so that you can restart your adventure from different points. For example, you might save a series of situations for this one mission, giving them names such as CARGOBA1, CARGOBA2, CARGOBA3, and so on.

12. If you find the movement of Ring Station 1 distracting, press F2 three or four times to slow the station's rotation. With the time scale setting reduced to a fraction of a second per second, you might want to use more fine thrust than usual to keep your MMU moving at an acceptable pace.

13. Press Alt-minus sign key or Alt-plus sign key (on the main keyboard) to adjust the distance between the chase craft and your MMU and therefore the MMU's size on the screen.

14. Use the fine thrust controls to gently move the MMU into the cargo bay. You might find it easier to make your final entry into the cargo bay using Cockpit view. But be sure to use Chase view to verify that your MMU is facing the cargo bay before you shift to Cockpit view.

Once you're inside the space station's cargo bay, you'll want to save the situation so that you can return. It's a pretty awesome place. As you wander around in the dark, you'll see blue rectangles, which are soft lights. And when you look back toward the cargo bay entrance, you'll see stars.

MISSION: A "Home Movie" of the MMU

One night Jon Solon created the nice situation that follows, which involves exploring Ring Station 1's cargo bay. During the development of Space Simulator, we were always looking for cheap ways to make "home movies"—which is to say, we would try to set up and save situations that would let you watch some action unfold, without resorting to Space Simulator's megabyte-gobbling video recorder. What Jon did in this case was to select Ring Station 1 as *both* the Assigned view and the tracking object. He then positioned the MMU just beyond the cargo bay opening, applied some thrust, and saved the situation. When he reopened the situation, we saw a great view of the MMU approaching and then entering the cargo bay.

Making a "Movie" of the MMU

1. Choose the Open Situation command from the Options menu, and open the situation you saved during the previous mission, in which you flew your MMU to Ring Station 1's cargo bay.
2. Choose the View Controls command from the Window menu. In the View Controls dialog box, verify that Ring Station 1 is your current Assigned view. If it isn't, choose the Assigned View button to display the Select Assigned View Location dialog box. In that dialog box, select Space Stations, select Ring Station 1, and then choose OK.
3. Verify that the tracking object is also set for Ring Station 1. If it isn't, choose the Tracking Object button, select Space Stations, select Ring Station 1, and then choose OK. Choose OK again to close the View Controls dialog box.
4. After the MMU is lined up for entry into the cargo bay, apply a small amount of thrust. You can position the MMU just about anywhere as long as it passes in front of, and preferably into, the cargo bay opening.
5. Choose the Location button to cycle to Assigned view.
6. Choose the Save Situation command from the Options menu or press the semicolon key. In the Save Situation dialog box, delete the existing name from the File Name box and type the name you want to use for this situation. So that you can refer to your situation later, type a description in the Description box and then choose OK.

If all goes well, you should see your MMU gliding into view as it flies toward and into the cargo bay. Any time you want to see this "movie," simply choose Open Situation from the Options menu, select the name you used for the situation, and choose OK. Once again you'll be able to view the MMU floating into the mammoth cargo bay. You can also experiment with different spacecraft for better or unusual views; try the same scenario with the ATL—or even the Galactic Explorer—instead of the MMU (and be sure to save the new situation under a different name).

BEHIND THE SCENES
The Spirit of Simulation

I was constantly impressed by the faithfulness to physics and Newtonian mechanics that Charles Guy and the team of developers brought to their work on Space Simulator. Charles spoke once about something he calls "the spirit of simulation."

"Being realistic requires a lot of knowledge about basic physics and mathematics and trigonometry," Charles said. "You can take shortcuts, but you have to understand why and also understand exactly what the implications are. The programming is very demanding because you must define everything much more explicitly and be more careful about all of the functional behavior. To me, it seems more intuitive to write a program that way; then, if I want to check it against something, I can check it against the real world. There is a natural, intuitive feel about a realistic simulation that seems obvious to me."

Charles believes that coordinate systems, which determine the placement of objects within Space Simulator's universe, and data structures, which contain all the relevant information about each object, are the foundation of good simulation. "At the beginning of the project, we spent weeks talking about coordinate systems, and we've spent months refining them. Closely related to that is the idea of data structures. As far as my simulation was concerned, I found that simply defining the data structures implied a lot about the way a mathematical equation should be written."





6

TWEAKING YOUR PREFERENCES

About halfway through the development of Space Simulator, the Preferences dialog box made its appearance. As we experimented with it, we discovered how exciting it is to decide for yourself exactly how you want to experience your space travels. Containing options for everything from scenery to sound, this dialog box brings *you* into the decision-making process. It lets you make your own choices—and also lets you change those choices whenever you like.

The Preferences dialog box allows you to create your own customized version of Space Simulator. You can tune the program for the most in beauty and realism or strip it down for raw speed and performance. And there is plenty of middle ground. Because the choices you make in the Preferences dialog box can have such a big impact on how you experience Space Simulator, this chapter explores them in detail.

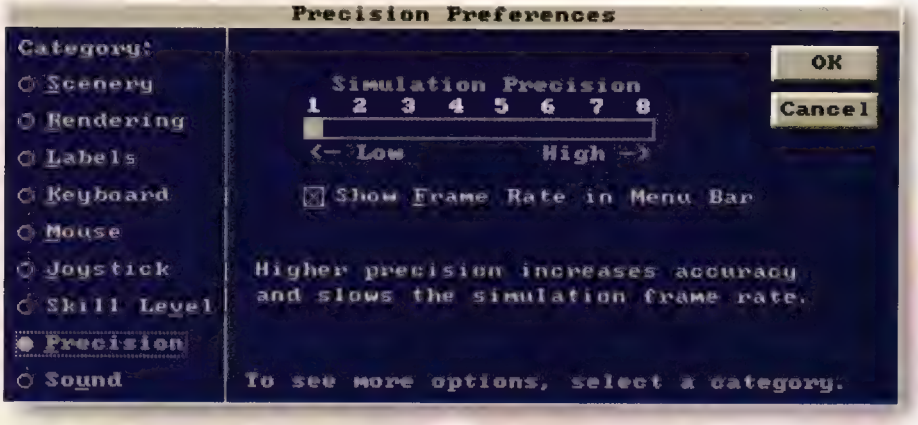
Opening the Preferences Dialog Box

To display the Preferences dialog box, choose the Preferences command from the Options menu. As you can see, however, there is actually no single "Preferences" dialog box. Depending on the option you select in the Category list, the title of the dialog box and its contents change. When you select Rendering, for example, the name of the dialog box becomes Rendering Preferences, and the contents show the options available for that topic.

Many of the preferences you can choose have at least some effect on the speed at which Space Simulator runs. So let's begin by opening the Precision Preferences dialog box, where you can turn on the frame rate display.

Precision Preferences

After you choose the Preferences command, select the Precision option button in the Category list to display the Precision Preferences dialog box.





TECH TIP

Although it will slow the action, a higher setting on the Simulation Precision scale might help you retain an orbit when you have significantly increased the time scale. Even with a setting of 8, however, you can be hurled out of orbit if you set the time scale for several years per second.

This dialog box contains the Simulation Precision scale, which lets you adjust how precisely Space Simulator calculates technical issues such as the orbital position of all objects (whether or not they're currently visible on the screen). You probably don't need to change the default setting of this scale (which is 1) unless you're trying advanced piloting feats such as orbital transfers or complicated docking in which greater precision might be useful. A higher setting will slow the simulation as the computer is forced to do more calculations per second. In fact, for some operations, a setting higher than 4 might even interfere with certain maneuvers because Space Simulator must repeatedly recalculate positions.

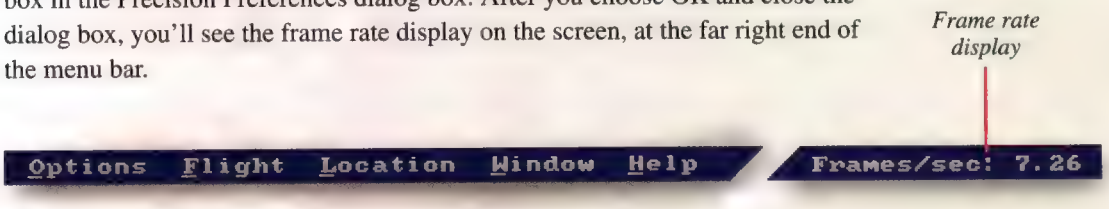
Even more important than the Simulation Precision scale is the other option in this dialog box, which lets you display the frame rate on your screen.

The Frame Rate Display

During the development of Space Simulator, you could sense that a subtle battle was going on between realism and beauty on the one hand and flat-out speed on the other. Key to this conflict was a nifty little "speedometer" that, from virtually the first alpha release on, sat in the upper right corner of the screen.

This readout displays the frame rate—that is, how many times per second the screen images (the "frames") are changing. This measure of how quickly or how slowly the screens change was originally intended as a development tool, not as part of the final product. But members of the Space Simulator team became so enamored of the frame rate readout that they decided to keep it in the product, albeit as an optional display.

To turn on the frame rate display, select the Show Frame Rate In Menu Bar check box in the Precision Preferences dialog box. After you choose OK and close the dialog box, you'll see the frame rate display on the screen, at the far right end of the menu bar.



On a 486/66 computer with a video accelerator card, you might see a frame rate reading as high as 14 frames per second, whereas on a 386 computer the reading might be more like 2.5 frames per second for the opening screen (or even lower if you turn on the Milky Way or otherwise increase the number of objects the computer must calculate and draw).

For instance, changing the Simulation Precision scale affects the frame rate. If you change the scale's setting to a higher number (by dragging the slider, clicking the scale, or typing the number on the main keyboard), the simulation precision increases and the frame rate slows; lowering the setting results in less precision and a faster frame rate.

BEHIND THE SCENES
The Frame Rate Display Races

As the Space Simulator project developed, members of the team held races to see whose computer could get the fastest frame rate. Everyone would use the same opening scenario and then watch the frame rate display to see who had the fastest machine. Nerds in paradise!

During the early alpha releases, the hot machines were those with 80486 chips running at 25 megahertz. As new computers came into Microsoft's games group, we tried the program first on 33-megahertz machines, and then on blazing 486/50s, which in turn were displaced by the speed of the 486/66. Somewhere along the line, local bus architecture and accelerated video cards entered the race; and shortly before Space Simulator was released, Pentium machines came on the scene.

Computer technology, especially on the hardware side, advances so rapidly that all of the above will sound humorous some day, like the tales still heard around Microsoft about the day the first 386/20 arrived or the whimsical complaints of having once paid $5,000 for an 80286 machine or, going even further back, for a dual-floppy 8086.

As time passes and technology races on, you'll be able to use the frame rate display to see how much faster the new computers can redraw the screens of Space Simulator. I expect that as things progress the simulation will begin to look as smooth as video.



Scenery Preferences

When you choose the Preferences command and select the Scenery option button, you'll see the Scenery Preferences dialog box. All but two of the scenery options are turned on by default and have little effect on speed. One exception is the Milky Way. When you turn on this scenery option, you'll see the beautiful blue glow of our galaxy, but you'll also absorb a measurable, though not overwhelming, hit on your frame rate speed. Jot down your frame rate speed with the Milky Way turned off. Then turn on this option, choose OK, and check the frame rate display to see the difference in speed.



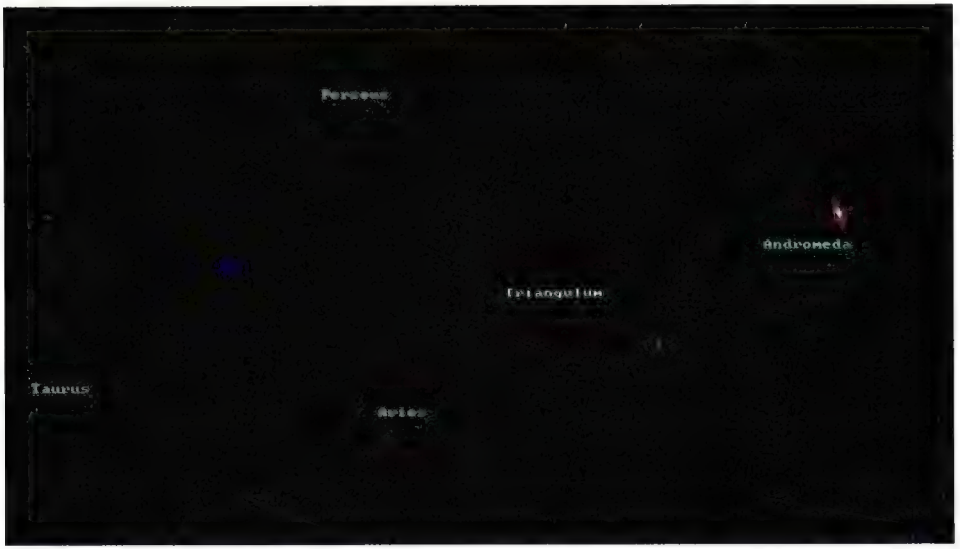


ASTRONOMICAL NOTE

The Milky Way is the wonderful cloud of stars in which we live. Containing more than 100 billion stars, our galaxy has a spiraling oval shape that extends for a staggering 100,000 light-years in diameter, with a center thickness of about 10,000 light-years. It's a big place to call home.

The other scenery option that is turned off by default is Constellation Boundaries. When you turn this feature on, you'll see the sky divided into its various constellation regions.

The boundary lines displayed on the screen don't outline the mythological figures for which the constellations were named; rather, the lines you see are the boundaries that astronomers use to plot the sky—the boundaries that allow an astronomer to say, for instance, that a newly discovered comet is leaving Auriga and entering Gemini. (To see the names of the constellations, use the Label Preferences dialog box, explained later in this chapter.)



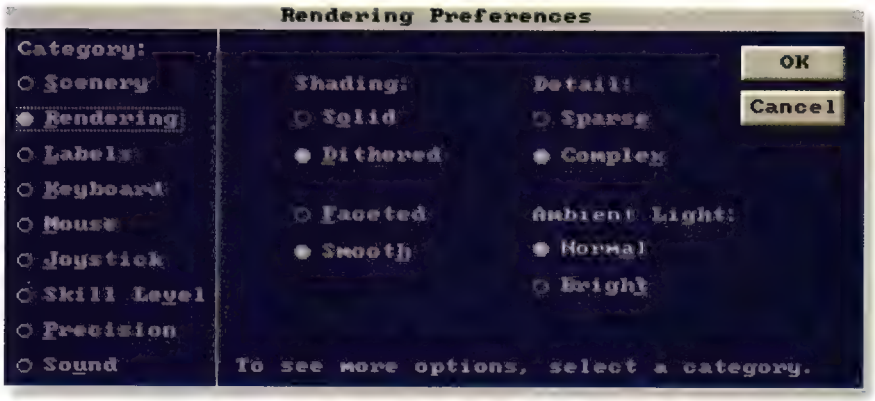
The Scenery Preferences dialog box also contains the Star Limiting Magnitude scale, which refers to the number of stars displayed on your screen. *Limiting magnitude* is the astronomical term for the brightness of a star. The lower the number, the brighter the star: The brightest stars are first and second magnitude; stars of fifth, sixth, or seventh magnitude are progressively fainter.

By default, the Star Limiting Magnitude scale is set for sixth magnitude. A setting of seventh magnitude allows Space Simulator to display more stars; a setting lower than sixth magnitude displays only the brighter stars. You can check before and after frame rate speeds to determine whether you want to change this setting.

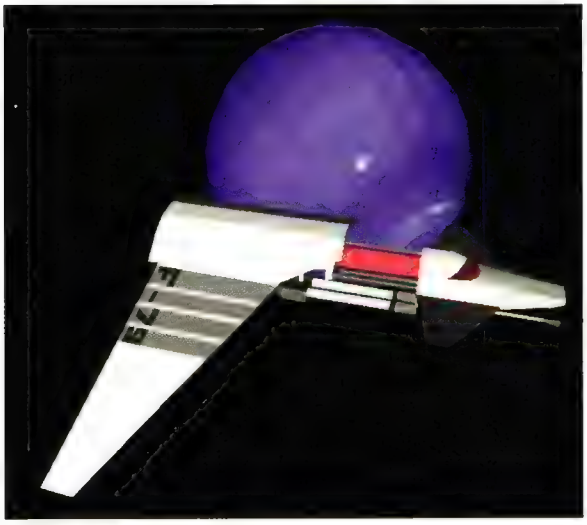
Turn off the Clouds On Planets check box in the Scenery Preferences dialog box if you'd like to see Earth's land masses free of cloud cover. (Although this option refers to "planets" in the plural, it applies only to Earth in version 1 of Space Simulator.) Leave the Other Spacecraft check box turned on, and you might come across other ships from your own fleet flying around. There's little reason to turn off the Space Stations, Asteroids, or Comets options; the simulation isn't slowed until you happen upon one of these objects, at which point it'll probably be a welcome sight.

Rendering Preferences

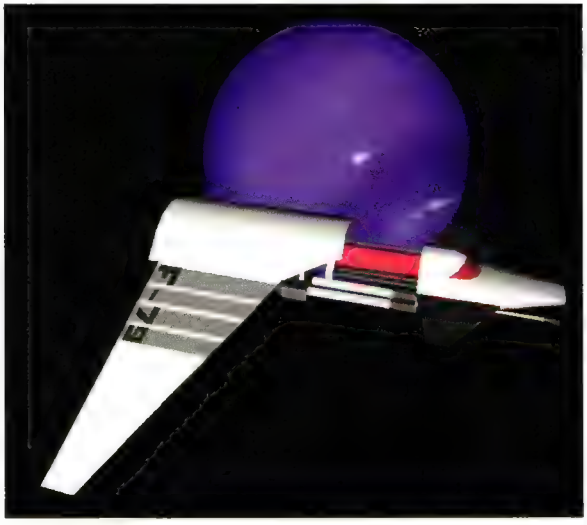
In the Rendering Preferences dialog box, you make the most important decisions about what you see in Space Simulator. In particular, the default shading settings, Dithered and Smooth, are the options that give stars, planets, moons, and other objects a beautiful, natural appearance.



It's an ugly universe when you select the Solid and Faceted shading options: You'll see objects not as round and smooth but as polygonal wire frames, which is a terrible way to adventure through space. With the Dithered and Smooth options, your frame rate slows somewhat, but the huge gain in beauty and realism more than makes up for any minor hit you take in frame rate.



When you select the Solid and Faceted options, objects appear rather angular.



Selecting the Dithered and Smooth shading options provides the most realistic view.

For the best-looking images, you should also set the Detail option to Complex rather than Sparse. The Complex setting enhances the smooth, realistic appearance of planets and other objects, although its visual effect is not nearly as drastic as that of your shading decisions. Selecting the Complex setting causes a modest reduction in the frame rate, but even on slower 386 machines, I prefer its increased realism. Try it for yourself, and see which you prefer.

Unless you have unusual lighting near your computer, you won't need to change the Ambient Light default setting of Normal. With standard room lighting, the Bright setting will in fact tend to wash out the images.

BEHIND THE SCENES
Getting Beyond Wire Frames

During the first several alpha releases of Space Simulator, the planets and other objects just didn't look that great. Spheres were not round and textured; instead, you could see all the annoying longitudinal and latitudinal lines that formed the sharp "wire frame" of each object.

Nearly everyone who looked at the early releases, including astronomer Carl Sagan, who saw a sneak preview, commented, "It sure would be nice if you could get rid of those lines." But the process that eliminates the wire frame lines requires extensive computation, and because of fears that this frame rate hit would be too much for Space Simulator to handle, we continued for some months to see wire frames where we wanted to see beautiful, smooth spheres.

Behind the scenes, the team at BAO was working to find strategies for displaying objects with dithered and smooth shading (technically called Gouraud shading) while minimizing the impact on frame rate. Slowly, they engineered this into the product. Over the next months, one planet at a time, one moon at a time, and then one asteroid and one star at a time appeared in their new incarnations. Then BAO began transforming the spacecraft as well.

Perhaps it is because I witnessed the long, demanding journey from the wire frames and angular objects of the early releases to the beautiful images of the final product that I feel so strongly that you would be cheating yourself if you turned off the Dithered and Smooth options in the Rendering Preferences dialog box simply to pick up a small increase in the frame rate.



Label Preferences

The Label Preferences dialog box was created in response to two of the questions that were most frequently asked by the Space Simulator team: Where are we? And what is that?

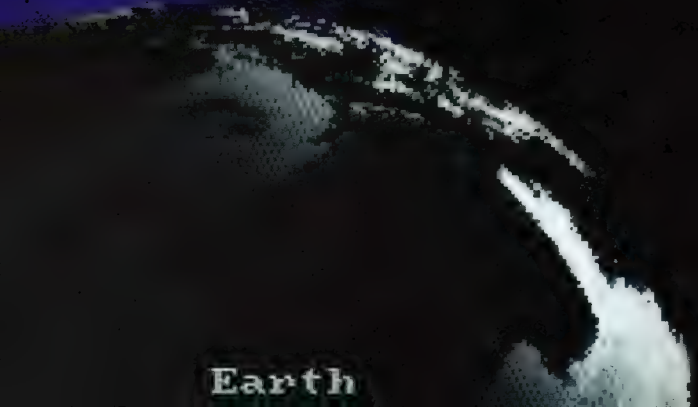
It became apparent that finding one's way back home would be a heck of a lot easier with some signposts to guide the way, signposts on a galactic scale telling you, for instance, that if Jupiter is here and Mars is there, Earth has to be this way! And, aside from their navigational function, labels are great simply for letting you know whether you are looking at stars, distant planets, moons, or asteroids.

TECH TIP

If you get lost in space, or if you see an object you want to identify, just press the L key to turn on all labels. Press the L key again to turn off all the labels except any that you have specifically selected in the Label Preferences dialog box.

The key to using labels effectively is restraint. If you turn on every possible label option, from Constellations to Space Stations, your screen will be so jumbled and overlapped with names that many of the labels will be unreadable. So, for example, if you are flying near Jupiter and want to identify its moons, open the Label Preferences dialog box, select only the Moons option, and then choose OK. Or, if you want to fly toward a certain constellation, select the Constellations option, and then choose OK.

The Map Objects option in the Label Preferences dialog box is turned on by default, and you'll probably want to leave it that way. When this option is on and you switch to Map view, the objects that appear on the map are labeled. (For more information about Map view, see "Customizing Map View," in Chapter 4.)



Neptune

Uranus

Mars

Venus

Mercury

Saturn

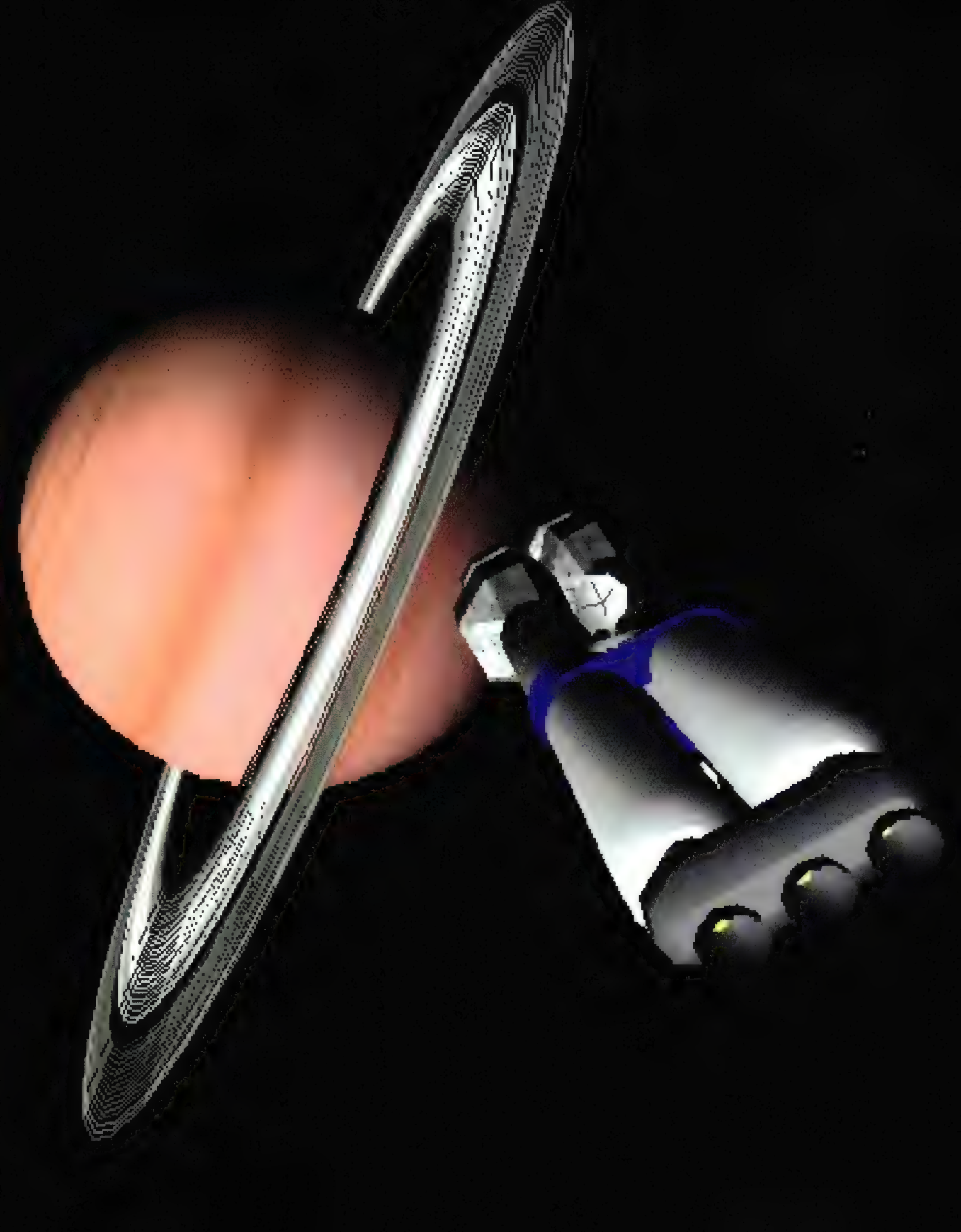
Keyboard Preferences

You've already learned how to customize the mouse and the joystick to accommodate the way you like to fly. (See "Flying with the Mouse" and "Flying with the Joystick," in Chapter 2.) Space Simulator also lets you customize keyboard controls.



In the Keyboard Preferences dialog box, you can adjust the Keyboard Sensitivity scale, whose default setting is 4. A lower setting results in a less sensitive keyboard—that is, you'll have to press a rotation key more times to reach a particular rotational speed—whereas a higher setting lets the keys respond more rapidly. You can try altering the settings to suit your own style of working.

The Pitch Control Keys setting is the most important part of this dialog box. One setting is Press Up Arrow Key For Pitch Up, which is how Charles Guy thought a spaceship should work. However, the default setting is Press Up Arrow Key For Pitch Down, which Jon Solon favored because it reflects the kind of stick-back flying action that Flight Simulator users, as well as pilots, have used since the beginning of flying—in other words, it's based on the action of pushing the controls forward to pitch down and pulling the controls back to pitch up. Those with Flight Simulator or real flight experience will probably prefer this setting, although it might seem counterintuitive to others.



Skill Level Preferences

The Skill Level Preferences dialog box lets you choose one of three settings—Practice, Intermediate, or Advanced—depending on how brave, adventurous, or skillful you feel. The default setting is Practice, which lets you maneuver your spacecraft without danger of crashing. In contrast, when you fly with an Intermediate or Advanced skill level, you run the risk of collisions—for instance, you'll crash if you enter a planet's atmosphere at an excessive speed.

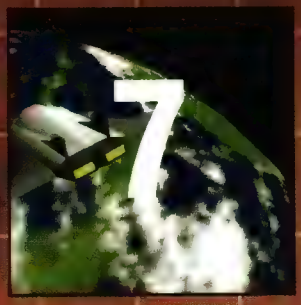
Likewise, when you are docking or landing, you must slow your craft to a maximum of 10 meters per second before contact if you're using the Intermediate setting or to a maximum of 5 meters per second if you're flying at the Advanced level; exceed these limits and you crash. Skill levels also affect your docking maneuvers: At the Intermediate level, your ship's alignment with the docking port can be off by as much as 45 degrees without crashing; at the Advanced level, your leeway is only 22 degrees.

Sound Preferences

The Sound Preferences dialog box offers three choices. The default setting turns off sound in the program. If you want to use either of the other two sound options, you must exit Space Simulator after making your choice and then restart the program so that the sound effects or music can be loaded into the system.

If you select the Sound Effects option, you'll hear sounds that are associated with specific actions, such as applying thrust or docking. Although sound doesn't travel through the vacuum of space, it can certainly resound from an engine room to a cockpit. On Space Simulator's larger ships, where this natural transmission of sound is lost, you can expect that the great star skippers would use speakers to pipe the sound in, just to hear what is happening with their beloved engines.

To hear digitized music while you fly through space, select the Music option, and then choose the Select Music button. The Select Music dialog box offers a choice of several digitized pieces, along with a brief description of each selection. The playback is rather basic, in order to match a wide array of users' sound cards. In fact, you can get better sounds from your home stereo system. But there is something charming about cranking through space as you listen to the ship's robotic sound system heroically recreating tunes from Earth.



GREAT LOCATIONS

The Location menu helps take the rocket science out of space exploration. It's the simplest and fastest mode of travel to a whole array of wondrous destinations throughout the galaxy—and beyond. Of course, the hard-core space pilots among you can fly to any of these destinations by the seat of your pants, and, as you'll see in Chapter 9, you can also travel using the autopilot and the flight computer. But for speed and simplicity, the Location menu is unmatched.

Conventional wisdom in the software industry holds that 80 percent of the people who use a computer application take advantage of only 10 to 20 percent of the software's features, using just enough to get a job done and never touching the rest of the program's power. Because the developers of Space Simulator were anxious to help users discover and enjoy as much of the product as possible, they created the Location menu as a great jumping-off point for exploring Space Simulator in depth. If you're ever wondering where to fly or what to do, just go to the Location menu, transport yourself to a distant world, and then go exploring!

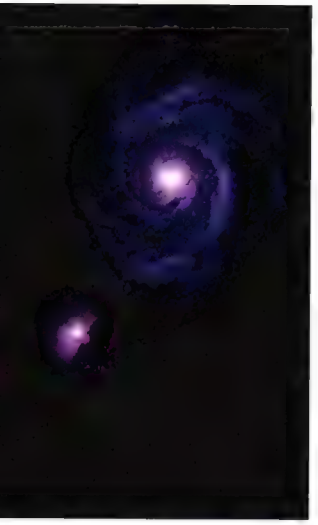


A Closer Look at the Location Menu

The Location menu offers nine categories of destinations, ranging from enormous objects in deep space, such as galaxies, star clusters, and nebulas, to smaller objects that include planets, moons, comets, and even space stations, spacecraft, and locations on the surface of a moon or a planet (Mars Base Marineris, for example). When you select any one of the categories from this menu, Space Simulator displays a dialog box that lets you choose your specific destination. You've already begun to use the Location menu in earlier chapters of this book, but it's well worth your while to investigate it in detail.

Enjoying What's Out There

Every time you go to the Location menu, you realize how many cool places you can visit within the realm of Space Simulator. Here is a quick glimpse of the first nine commands on this menu and the categories of objects they represent—and we'll help you brush up on your high school astronomy in the bargain. (We'll discuss Set Location, the last command on the menu, later in this chapter.)



Deep Sky

This category includes objects found beyond our solar system, such as galaxies, nebulas, and star clusters. A *galaxy* is a great island of stars, usually containing anywhere from several million stars to hundreds of billions. Our own Milky Way is a galaxy.

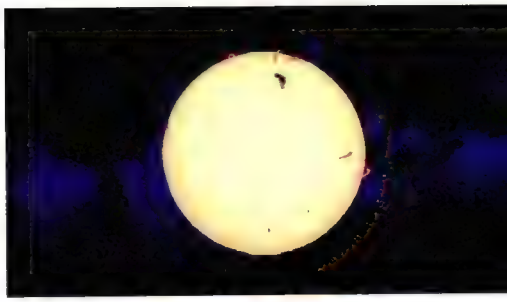
A *nebula*, such as the Crab nebula, is a vast cloud of hydrogen, the gas from which stars are made. Some nebulas—Orion, for instance—are actually stellar nurseries in which stars are growing as they gravitationally attract more and more hydrogen into their forming selves.

Star clusters, such as the Pleiades, are groupings of related stars that originated from the same mass of hydrogen in space. The great star clusters, which can contain tens of thousands of stars, are called *globular clusters;* Omega Centauri is one of the best known.

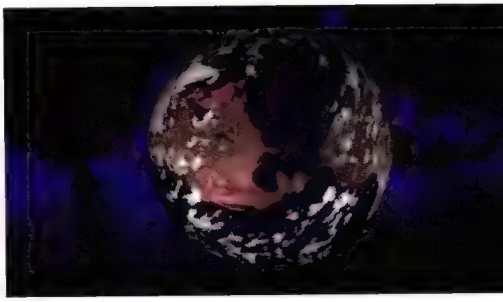
Stars

Stars, the great givers of light within the universe, are primarily huge balls of hydrogen. A star exerts so much gravitational pressure upon itself that at its core hydrogen atoms are fused in a nuclear reaction, producing enormous power.

Space Simulator's list of star locations includes the three major types of stars: hot, young blue stars such as Altair; middle-aged yellow stars such as our Sun; and giant red oldsters such as Betelgeuse and Antares. Our Sun is a typical middle-aged star, with a diameter of 1.4 million kilometers, a vast size compared to the diameter of Earth, which is less than 13,000 kilometers.

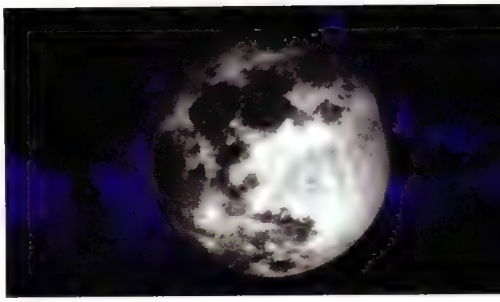


But even the Sun is dwarfed by the giant red stars. Betelgeuse collapsed upon its own core after exhausting its supply of hydrogen, exploded outward, and gained an extension on life as it began to fuse its helium. Its incredible diameter is now measured in hundreds of millions of kilometers.



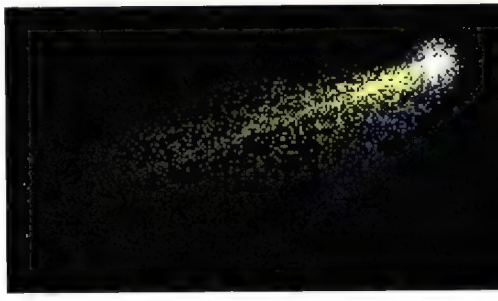
Planets

Planets, such as Earth or our neighbors Venus and Mars, are large objects that orbit a star but don't have the hydrogen and mass to be stars themselves. The gaseous giant Jupiter, however, the largest planet in our own solar system, is thought to be an almost-star—that is, a planet that might have become a star if more hydrogen had been available during its formation.



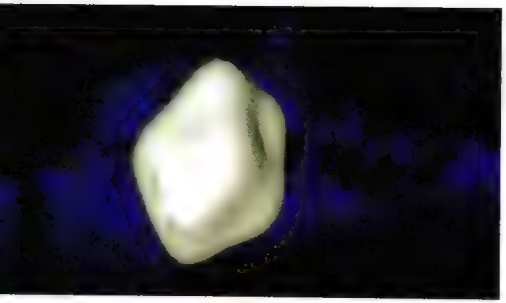
Moons

Objects that orbit a planet rather than a star are called *moons*. The moons of our solar system range in size from Deimos and Phobos, the tiny pair of moons orbiting Mars, which are only 12.8 kilometers and 22.6 kilometers in diameter, to Jupiter's moon Ganymede, the largest moon in our system. With a diameter of 5,262 kilometers, Ganymede is bigger than the planets Mercury and Pluto.



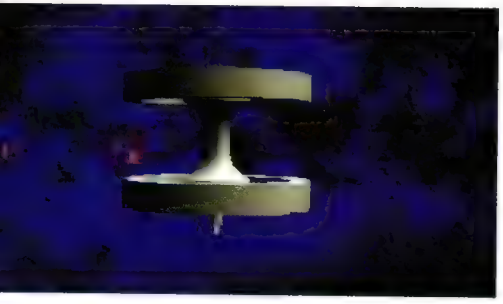
Comets

The great balls of primordial ice that orbit our Sun are *comets*. Some comets have extremely eccentric orbits that carry them well beyond the farthest planet, Pluto. The beautiful tail displayed by a comet as it glides by Earth is caused by sunlight glowing against the trail of gas and debris the comet leaves in its wake. A comet's tail becomes larger as it nears the Sun because the Sun's heat melts some of the ice, freeing gases and debris.



Asteroids

An *asteroid* is a bit like a cross between a moon and a planet. Asteroids are generally small and moonlike in size, ranging from the asteroid Ceres with its 1,000-kilometer diameter to the asteroid Europa, whose diameter is only a few hundred kilometers. (On the smaller end of the size range, asteroids are in effect floating boulders.) Unlike moons, however, asteroids orbit a star, as planets do. Most asteroids in our solar system exist in an orbital band located between Mars and Jupiter. This area, called the *asteroid belt*, has given rise to many science fiction stories about miners who work in space.



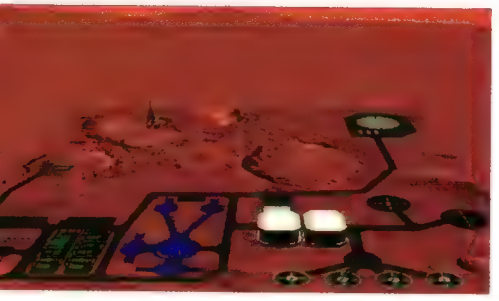
Space Stations

The various stations in Space Simulator are like tiny cities floating in space. Someday, real space stations could perhaps become like floating gas stations or hotel complexes and then grow into major manufacturing or trading centers. Within Space Simulator, this command on the Location menu allows you to immediately transfer yourself from one space station to another.



Spacecraft

The Spacecraft command lets you return to a ship you've left behind. For example, you can begin a flight in the Galactic Explorer, deploy the ATL, fly the lander to a space station, dock, and choose the Vehicle Transfer command from the Flight menu. You can then choose the Location menu's Spacecraft command and select the Galactic Explorer to return to the mother ship with the ATL *and* the space station you docked with. (Don't confuse the Spacecraft command on the Flight menu with the Spacecraft command on the Location menu. The first one changes the spacecraft you are flying; the second moves your ship to another spacecraft.)

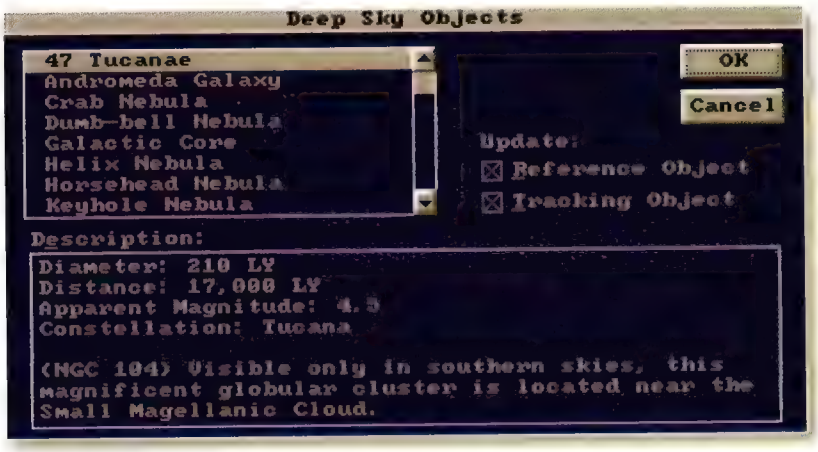


Surface

The Surface command lets you choose a specific location on the surface of an object in our solar system. Select Launch Pad 39B, for instance, and you are transported to Cape Canaveral on Earth. Select Taurus-Littrow to move instantly to that area of our Moon, or travel to the surface of Mars by selecting Mars Base Marineris.

Traveling with the Location Menu

Part of the elegance of the Location menu is that once you've seen one of its dialog boxes, you've seen them all. Let's use the example of the Deep Sky Objects dialog box to see how all these dialog boxes work



Choose the Deep Sky command from the Location menu to display this dialog box. You can scroll through the list box in the upper left to find a destination in deep space—the Crab nebula, perhaps, or maybe the Andromeda galaxy. When you select (highlight) an object, Space Simulator provides details in the Description box—for example, when you select the Whirlpool galaxy, you'll learn that its diameter is 100,000 light-years, that it is a whopping 35,000,000 light-years from Earth, and that observations of this galaxy led to the discovery of the structure of spiral galaxies. When you're ready to travel to a selected object, simply choose OK.

After you choose OK, the object you selected becomes by default your new reference object and your new tracking object. If you don't want to change your existing reference object or tracking object when you go to your new location, simply turn off either or both of these check boxes in the dialog box before choosing OK.

When you choose Stars, Planets, Moons, or any of the other categories from the Location menu, you'll see a similar dialog box, whose features work just like those in the Deep Sky Objects dialog box. This consistency makes the Location menu an easy-to-use launching pad for new adventures across the solar system and the galaxy.

"Trembling with excitement I watched a world so new and unknown to me, trying to see and remember everything. Astonishingly bright cold stars could be seen through the windows. They were still far away—oh, so far away—but in orbit they seemed closer than the Earth. But the point was not the distance (my distance from the Earth was but a drop in the ocean compared to the light-years separating us from the stars) but the principle. Man had overcome the force of Earth's gravity and gone out into space."

—Yuri Gagarin, Soviet cosmonaut, the first human to enter space

Arriving in Style

When you use the Location menu to travel to a new destination, Space Simulator delivers you there in style. Whether you are traveling to a nebula, a star, a planet, or any other object, Space Simulator places you in a stable orbit 4 radii from the object. From there, you can take the controls and fly your spacecraft closer, perhaps even land on the object, or just take off and explore the surrounding neighborhood.

Notice that you can also jump to a space station or another spaceship. If you use the Location menu's Spacecraft command to travel to one of the available ships, you can fly your current ship closer and dock with the new spacecraft. Or you can choose the Space Walk command from the Flight menu and fly over to the new craft in the MMU. Once you've docked, you can use the Vehicle Transfer command from the Flight menu to take the controls of the new ship. This is a great way of bringing more than one spacecraft onto your screen.

MISSION: Flying Between the Martian Moons

Here's a mission reminiscent of the Golden Age of science fiction, or perhaps of a Sunday morning Calvin and Hobbes cartoon. Using the Location menu, you'll "materialize" at the tiny moon Phobos and then use the head-up display to fly yourself to the almost toy-sized moon Deimos.

Using the Head-Up Display



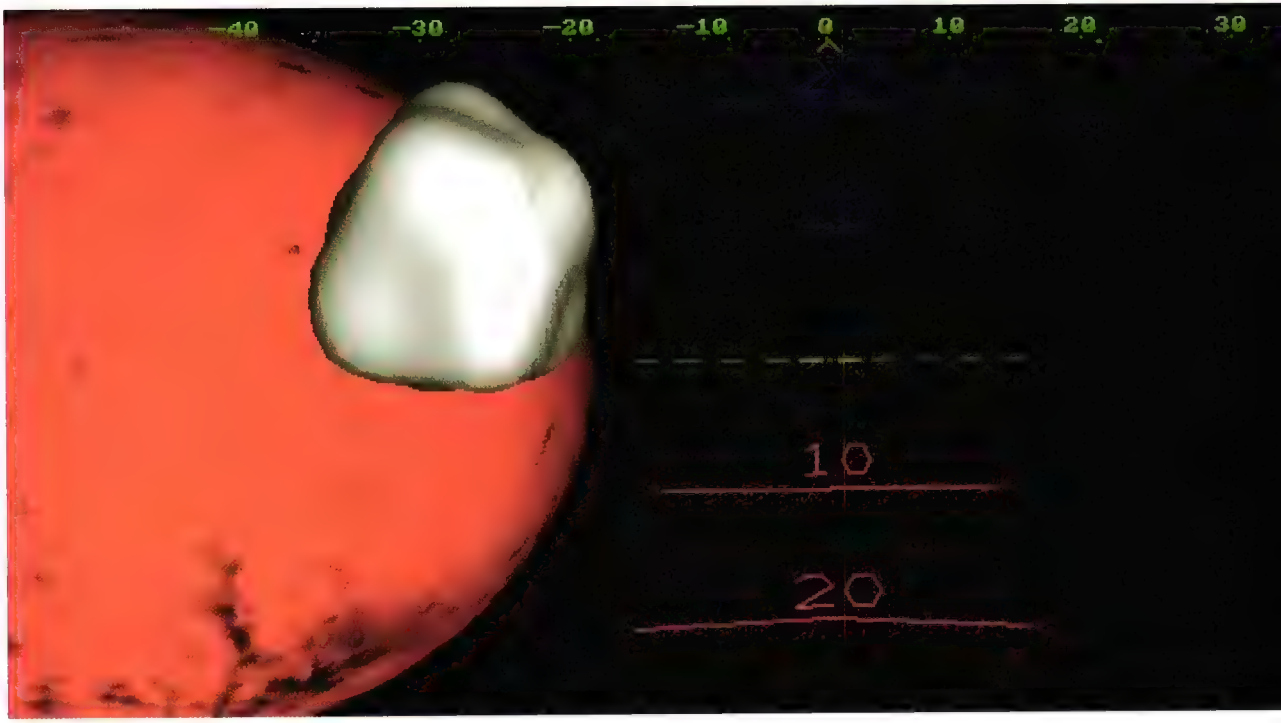
This mission gives you a chance to try out Space Simulator's head-up display. This powerful piloting tool lets you navigate your ship by using visual displays that are superimposed on your cockpit window. With the HUD, you can zero in on whatever you've set as your reference object.

TECH TIP

Remember that you can recenter the location tabs on the panning bars by clicking the Reset button or pressing Alt-keypad 5.

The head-up display is available only when you are in Cockpit view, when you are using panning rather than tracking as your viewing method, and when the location tabs are centered on both the horizontal and vertical panning bars. To turn on the HUD, press the H key or choose the Show Head-Up Display command from the Window menu. (To turn it off, press H again or choose the Hide Head-Up Display command.)

The HUD provides an excellent visual reference as you navigate. You'll often want to use it in combination with the attitude display readouts for yaw, pitch, and roll, which indicate more precise measurements of your headings.



Flying from Phobos to Deimos

1. Choose the Moons command from the Location menu. In the dialog box, select Phobos from the list of moons, read the description, and then choose OK. Your ship is instantly transported to a location in the vicinity of Phobos.
2. To be sure that you have a good view and that the moons of Mars are well positioned, we'll set the time for a period of good sunlight. Choose the time display on the instrument panel. In the Time dialog box, change the entry in the Time box to 12:15:00. (This is Universal time.) Change the date in the Date box to 01 Jan 2100 and choose OK.
3. Press the H key or choose the Show Head-Up Display command from the Window menu. Space Simulator places the head-up display over your cockpit window, like a transparency. You can use this display to fly to the second moon of Mars, Deimos.
4. To set Deimos as your reference object, choose the reference display on the instrument panel. In the Select Reference Object dialog box, select the Moons option button. Then select Deimos and choose OK.

   The reference display now indicates how far your spacecraft is from Deimos. Be sure that this display shows radius and altitude rather than distance (which would indicate the distance to the core of the moon); if necessary, press Alt-S or click the bottom half of the display (rather than the word Reference) to change the readouts. The altitude reading, which is more relevant to pilots trying to avoid collisions, tells you how far you are from the surface of the moon.



TECH TIP

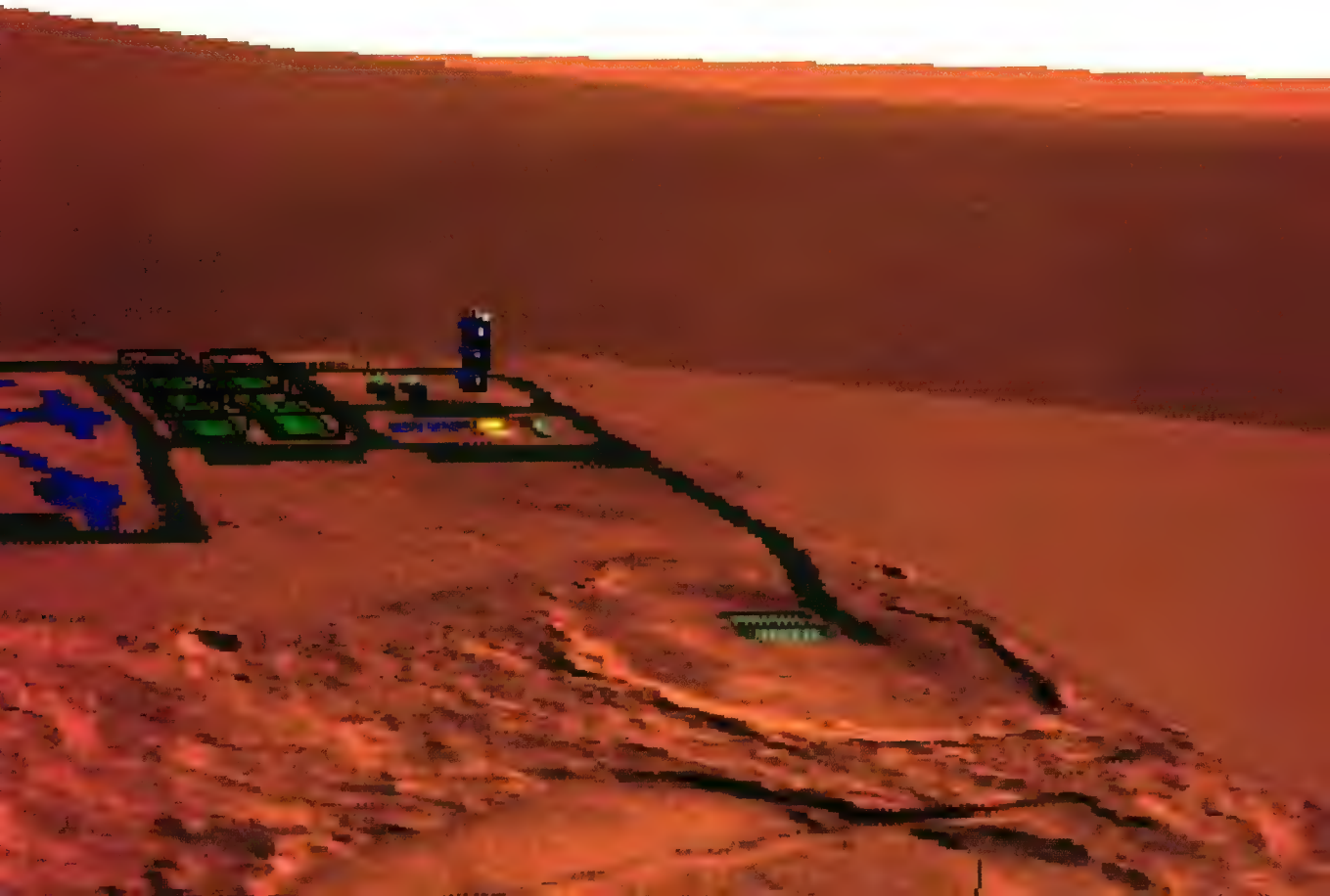
Universal time, also called Greenwich mean time, is the standard measure of time used on Earth, based on the Sun's daily crossing of the prime meridian (0 degrees longitude). Someday, of course, there will be Martian time, or some other measure that is truly "universal." In the meantime, Universal time provides a useful standard to help you move to specific places and times within Space Simulator.

5. Apply thrust, and begin to steer your way around Phobos. An initial speed of about 1 or 2 kilometers per second is a comfortable way to enjoy the view during this close flyby. For an easier flight, you can switch to slew control; for a more realistic flight, remain in flight control.
6. Using the right and left arrow keys or the joystick, yaw your spacecraft until the yellow inverted-V marker along the top of the HUD points to 0. This action aligns you horizontally with Deimos.
7. Using the up and down arrow keys or the joystick, pitch your craft so that the green center dot is kept between the two yellow lines in the center of the screen, aligning you vertically with Deimos.
8. Press the keypad slash key or the keypad asterisk key, or hold down the Ctrl key and use the joystick, to position the blue and red attitude grids so that they are straight up and down, with the blue grid above the red. This action aligns you with the equatorial plane of Deimos.
9. Choose the Save Situation command from the Options menu or press the semicolon key. In the dialog box, enter a filename and choose OK. (It's useful to save the situation frequently when you embark on an adventure that requires a lot of initial setups.)



10. Increase your velocity to fly closer to Deimos. Monitor the altitude reading to be sure that you don't approach the moon too quickly.
11. Continue to keep the head-up display centered as you move in on Deimos. As you close within the final several miles, slow your ship. Notice that if you cut all your velocity, Deimos continues to move because it is still in orbit around Mars.

After you arrive at Deimos, you could continue your trip by setting the surface object Mars Base Marineris as your reference object and using the HUD to fly to the Martian base. (The ground coordinate system will have you flying there upside down, but that's fun too.) If you are flying a large starship such as the Galactic Explorer, you can leave the ship in orbit and launch the All Terrain Lander, which is used for planetary landings. Or, once you are on the ground, you might enjoy taking a "walk" in the MMU. If it is dark when you arrive, just use the Time dialog box to set a slightly different time. Have fun exploring the base!





ASTRONOMICAL NOTE

To understand some of the incredible distances in space, think of a coffee cup as our Sun and a chocolate chip 1 inch from the cup as Earth. On this scale, a chocolate chip representing Jupiter would be 5 inches from the cup, with a chip for Pluto 40 inches away.

You'd need to place a chocolate chip representing our nearest neighboring star approximately 4.5 miles away from the cup. And there wouldn't be room on Earth to position a chip for the Andromeda galaxy—even within this scale model, it would be more than 2 million miles away.

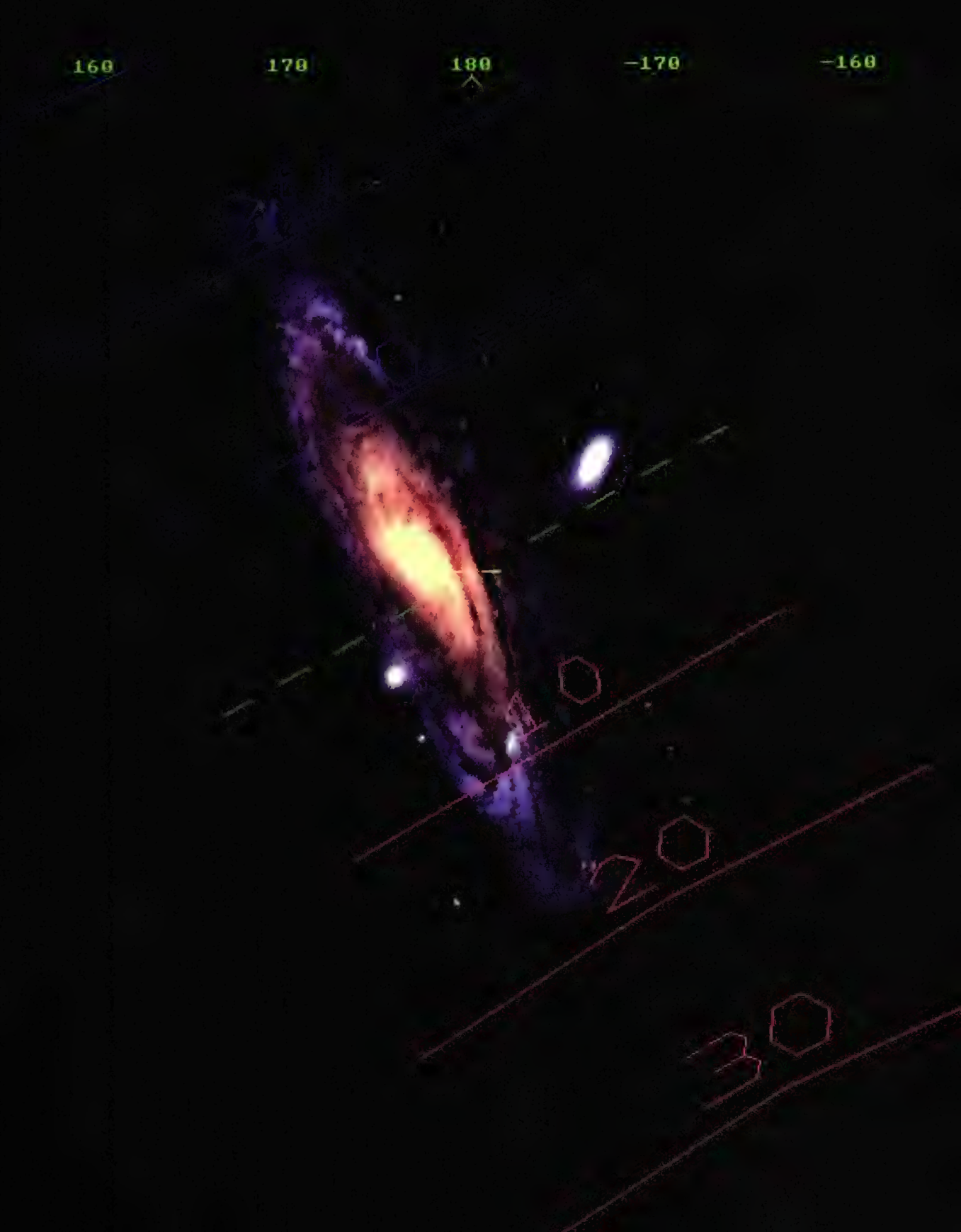
MISSION: A Journey from Andromeda to Earth

What makes this mission both important and enjoyable is the vast distance of empty space you must cover. The trip begins near the Andromeda galaxy. Andromeda is the spiral galaxy nearest Earth—but it is also a stunning 2.2 million light-years away from our home planet. Containing an estimated 400 billion stars, this magnificent galaxy is about twice the size of our Milky Way.

You'll probably want to make this flight with slew control turned on, with full velocity of just under light speed, and with the head-up display turned on. And unless you have a huge amount of time on your hands—say, a few million years—you'll want to use the time scale to crank up the passage of time.

Flying Home from Andromeda

1. Choose the Deep Sky command from the Location menu. In the Deep Sky Objects dialog box, select Andromeda Galaxy and choose OK. Space Simulator places you in the neighborhood of the galaxy, although you are still a long way from it.
2. Choose the reference display on the instrument panel. In the Select Reference Object dialog box, select the Stars option button. Then select Our Sun and choose OK. The reference display now indicates your distance from the Sun, which is more than 2 million light-years away. (You are so far away from home that you cannot set Earth as your reference object until you return to our solar system.)
3. Press the H key or choose the Show Head-Up Display command from the Window menu.
4. Yaw your spacecraft until the yellow inverted-V is centered beneath the 0 reading at the top of the head-up display.
5. Pitch your craft to center the green dot between the two yellow lines in the middle of your screen.
6. Press the Y key to switch to slew control. (I prefer making this journey with slew control, although experienced star pilots might enjoy using flight control.)
7. Press the F8 key to achieve maximum velocity—just below the speed of light—in slew control (or to apply maximum thrust if you are using flight control).
8. Press the F1 key several times, easing the time scale up slowly. Watch the effect—or the lack of effect—on the distance readout. Even with a time scale setting of 1 hour per second, the distance remains unchanged. With the normal time scale setting of 1 second per second, you would have to sit at your computer for more than 2 million years before you returned home to our solar system.


160
170
180
−170
−160
40
20
30

9. Increase the time scale setting to 68.1 years per second. At this rate, you begin to see a reduction in the distance readout. As each second goes by, it is as if you had spent 68 years piloting this spaceship. Click either end of the horizontal panning bar to look out the "back window" of your ship. After 68 years, has Andromeda moved much? After 2 seconds, more than a whole lifetime of watching Andromeda, has it moved even at the speed of light? At this time scale setting, it will take you more than 8 hours to make the crossing to the Sun. (Remember to recenter the horizontal panning bar so that you can use the HUD again.)
10. Bring the time scale to its maximum setting of 8,710.5 years per second. The light-years are ticking away nicely now, but you still need some patience. Even with nearly 9,000 years flying by each second, the speed isn't fast enough to sweep you home immediately.
11. When the distance to the Sun drops to less than 1 million light-years, press the F2 key once to slow by half the rate at which time passes. At this point, the time scale is your main speed control.
12. When the distance to the Sun is less than 500,000 light-years, reduce the time scale setting to 2,177.6 years per second to avoid blowing past our star. You could also decrease the time scale setting at your own pace. Generally, you might want to reduce the setting to just a few years per second by the time you are within 1,000 light-years of the Sun. And before you get much closer than 100 astronomical units from the Sun, you might reset the time scale back to the standard 1 second per second.
13. Once you're back in our solar system, change your reference object to Earth and continue home.
14. Adjust your yaw, pitch, and roll so that the HUD continues to be zeroed in on Earth. You can slow down the time scale whenever you need to make steering corrections and then speed it up again. The nearer you get to Earth, the more you need to adjust the HUD. You won't be able to see Earth for a long time, but just keep the green dot centered between the two yellow lines in the middle of your screen.
15. Take a look at the date! Watch as the days and years tick off. (I began this mission, for instance, on 31 August 2001. By the time I moved into Earth orbit, the date was 12 June 2633676.)
16. Press the keypad minus sign key to reduce your velocity. If you are using slew control, each keypress reduces your velocity by half. You won't begin to see Earth until you are about a half million kilometers away. Keep your eye on the distance readout to be sure that you reduce your speed in enough time to avoid blasting past Earth. (If you do blast past, just slow down, and use the HUD to turn your craft around and get zeroed back onto Earth.)
17. When you are within 100,000 kilometers of Earth, press Alt-S or click the reference display to change the readout from distance (which indicates your distance from the center of Earth) to radius and altitude (which indicates your altitude above the surface of Earth).



ASTRONOMICAL NOTE

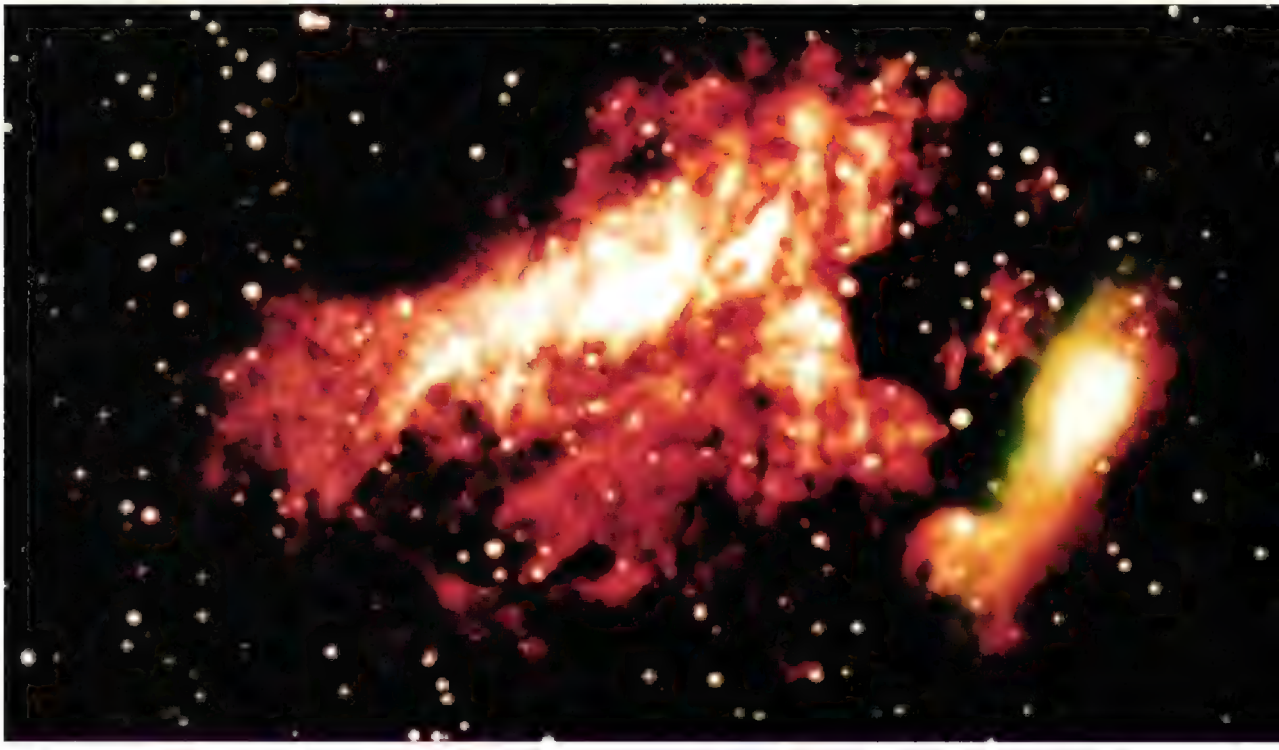
An "astronomical unit" is the average distance between Earth and the Sun, about 150 million kilometers. This unit of measure gives you a handy way to conceptualize distances. For instance, instead of describing the distance between Pluto and the Sun as 5,965,200,000 kilometers, you can refer to it as 40 astronomical units—which helps you immediately understand that Pluto is 40 times farther away from the Sun than Earth is.

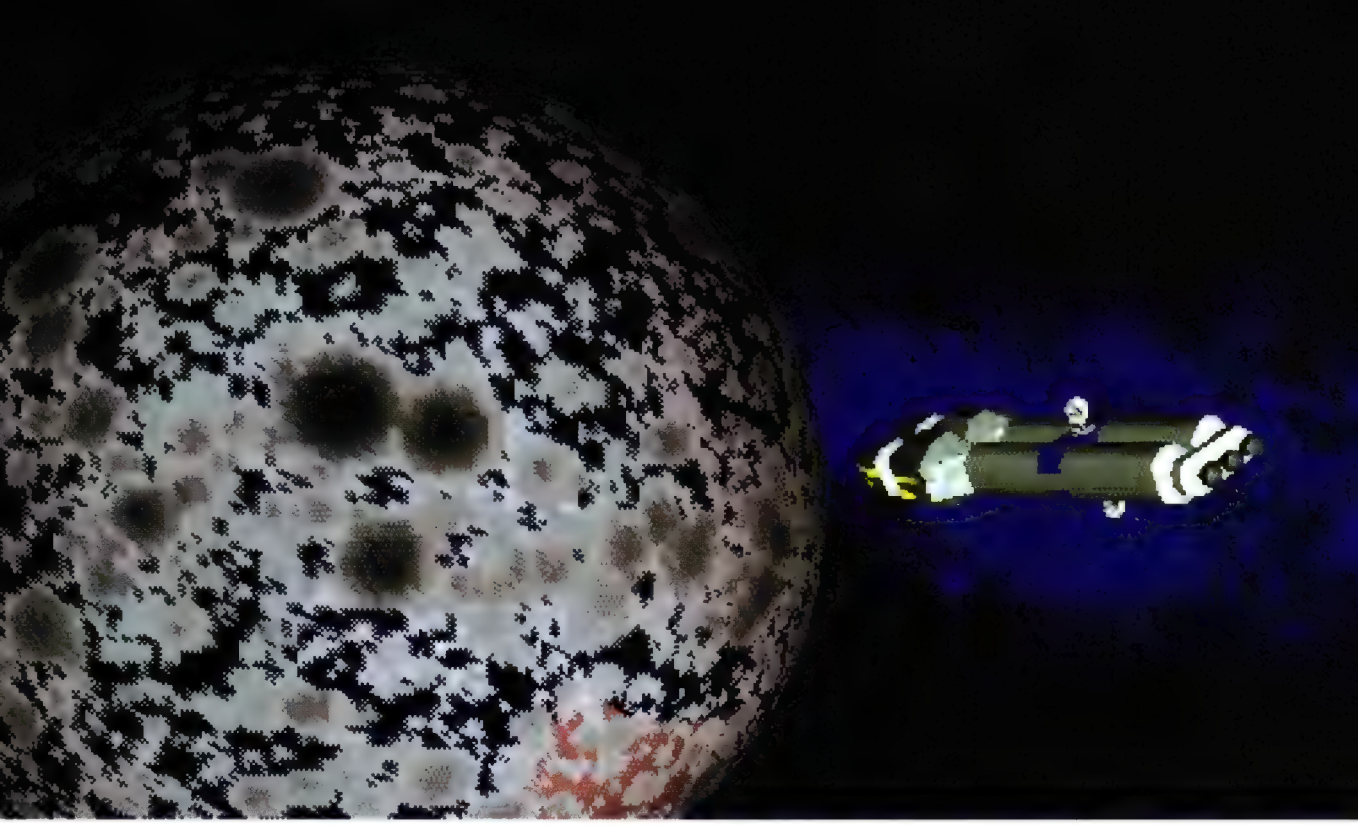
Sit back and enjoy the view as you near Earth. You can continue on to land on Earth, enter an orbit, search for a space station, or embark on another journey. Remember to set your new destination as the reference object so that you can monitor the distance remaining as you travel and use the HUD to find your destination.

Exploring New Solar Systems

Space Simulator assumes that our Sun isn't the only star to have planets. In fact, a large percentage of stars are likely to have planetary systems. Although we have no pictures of these planets to confirm their existence, you won't have to wait for the pictures within Space Simulator because all 20 stars that can be reached through the Location menu have been given planetary systems. The Location menu provides a fast and easy way of traveling to stars to look for their planets and moons.

To keep dialog boxes a reasonable size, you won't see the names of these planets and moons listed until you travel to a specific star. But once you reach the star, the names of the objects in its solar system appear in the appropriate dialog box. For example, if you visit the star Aldebaran and then choose the Planets command from the Location menu, the Planets dialog box displays all the names of Aldebaran's planets. Likewise, Aldebaran's moons are listed in the Moons dialog box.





MISSION: Visiting the Planets of Polaris

This mission takes you on a journey that was more than two years in the making, as it was at least that long from the inception of Space Simulator until the creation of the first new solar system. Initially the big question was "Will there be planets around the other stars?" And then it became "When are the planets coming?" Everyone was eager to wave farewell to our Sun and its planets and to visit worlds around other stars such as Polaris, our destination in this mission.

Visiting the First Planet of Polaris

1. Choose the Stars command from the Location menu. In the dialog box, select Polaris, read its description, and choose OK.
2. Now choose the Planets command from the Location menu. In the dialog box, you'll see a list of names for the planets orbiting Polaris. Notice that the names have a somewhat generic character: The first planet in the Polaris system, for instance, is called Polaris I.
3. Select Polaris I from the list and choose OK. You are now in a stable orbit 4 radii from Polaris I, the planet closest to Polaris in this system.



Now that you've arrived, go exploring! Switch to Chase view, and change the chase craft perspective from relative to absolute so that you can see your spacecraft turn and maneuver against the backdrop of the planet. Fly nearer the planet to examine its atmospheric and land-mass characteristics; draw a sketch of what you see. Deploy the All Terrain Lander, and circumnavigate the planet. If you discover an especially interesting area, save the situation so that you can return to the spot later.

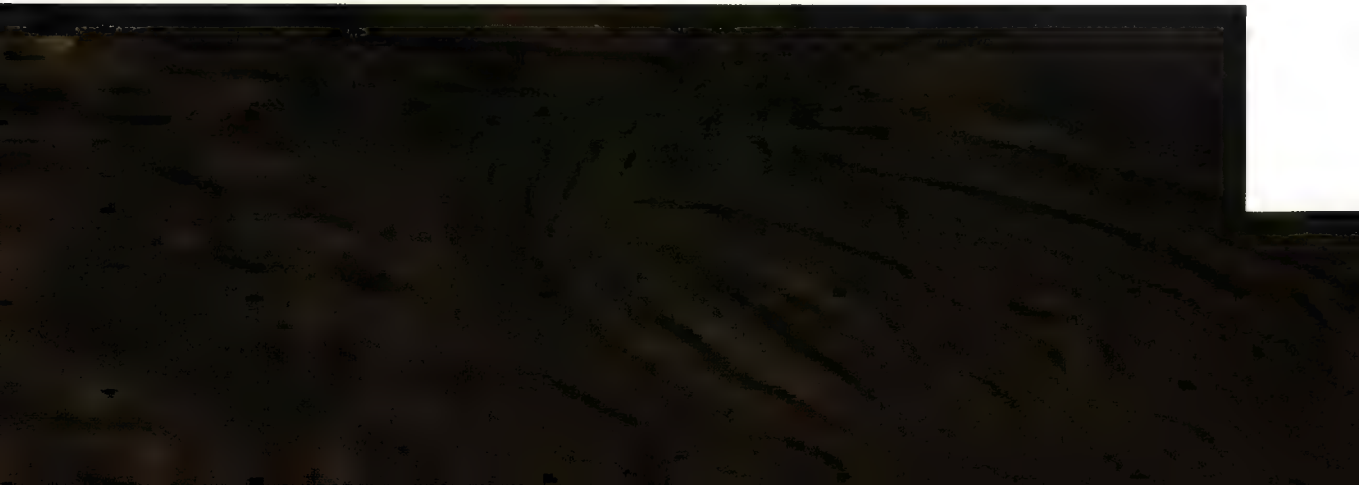
If you want to go to another of Polaris's planets, you can choose the Planets command from the Location menu, or you can set one of Polaris's planets as your reference object and then use the head-up display to navigate your way there.

To visit any of the moons of the Polaris solar system, simply choose the appropriate command from the Location menu. The Moons dialog box lists the moons of Polaris as Polaris I M1, Polaris I M2, and so on.

ASTRONOMICALLY SPEAKING
A Passion for New Planets

The idea of undiscovered planets orbiting distant stars seems to capture people's imagination and stir their curiosity. At this writing, the only known planets in our entire universe are the nine that orbit our own Sun. But most astronomers believe that billions upon billions of planets must exist, accompanying the billions of stars. With luck, the Hubble Space Telescope or some of the new, large, land-based telescopes being created might someday allow us to confirm that other planets are indeed out there. Once the first planet of another solar system is found, we will have a new way of looking at the universe and at our own place in it. Rather than making us feel less special, the discovery of new planets should enable us to feel less alone.

***Postscript*: As if to accent how quickly astronomers are making new discoveries these days, the *New York Times* reported only weeks after I wrote the paragraph above that "scientists now feel sure that they have unqualified proof of the existence of other planets far beyond the solar system." Dr. Alexander Wolszczan, an astronomer at Pennsylvania State University, reported in the journal *Science* that observations made with radio telescopes had confirmed the existence of three planets in orbit around a pulsar star about 1,500 light-years away, in the Virgo constellation. Because a pulsar emits invisible radiation instead of sunlight, scientists speculate that these planets host no life (or at least no life in a form that humans might understand).**



Using the Set Location Command

The universe is a big place. The first nine commands on the Location menu can take you to only a tiny fraction of the possible locations in space—a sort of "Greatest Hits of the Universe." But in the Set Location command, nestled at the bottom of the Location menu, you have a powerful tool that can quickly take you anywhere you want to go. And because you can do some pretty complicated designing and custom traveling with it, the Set Location dialog box is a nerd's delight. (I'm using the word "nerd" in the proper and hallowed context of MIT and Carnegie-Mellon University, the great computer science schools, which see the word as a badge of honor.)

After you choose the Set Location command, the Base Object button should be your first stop in the Set Location dialog box. Choose this button to produce a second dialog box, called Select Base Object, which is a functional equivalent of the entire Location menu. Here you select first the type of location you want to visit—a star or a planet, for instance—and then the name of the specific object.





TECH TIP

When you travel to a celestial object and arrive in the dark, the usual remedy is to change the date or to accelerate the passage of time until the light improves. You can achieve the same result by changing the longitude in the Set Location dialog box. Add or subtract about 180 degrees of longitude, and you'll move to the opposite side of the object, which should be in the light.

As an example, select Asteroids from the Object Type list in the Select Base Object dialog box, and then select Pallas from the list of asteroids. When you choose OK, you return to the Set Location dialog box, with Pallas set as your current base object. At this point, you get to decide exactly where you want to be in relation to Pallas by simply entering the appropriate latitude and longitude in these boxes. You'll need to use the DDD MM SS format for coordinates (degrees, minutes, and seconds), as indicated beneath the boxes.

To the right of the Latitude box, select the North or the South option button to designate whether this coordinate refers to a latitude north or south of the object's equator. The East and West option buttons beside the Longitude box determine whether your longitude coordinate is east or west of the object's prime meridian.

Next you can decide precisely how far away you'll be from the base object. You must first choose whether to calculate this measurement as distance (measured from the core of the object) or as altitude (measured from the surface of the object). For most purposes, altitude is the best selection and is least likely to get you into trouble.

After you select the Distance or the Altitude option button, enter a specific number in the accompanying Distance box, and then select a unit of measure from the list on the right. As you do this, it's important to think about both the purpose of your mission and the type of object you've chosen as your location.

For example, if you enter 400 as your altitude in relation to Pallas and then select meters as a unit of measure, you'll have a super closeup view, from only 400 meters away. Select kilometers instead of meters, and suddenly your 400 units put you quite a bit farther away. By the same token, a distance of 3 radii is small when the base object is a comet or an asteroid but vast when the object is a galaxy.

Your final choices in the Set Location dialog box are made in the Update section. By default, your newly selected base object becomes both the reference object and the tracking object. But if you want to retain your previous reference object or tracking object, just turn off either or both of these check boxes.

BEHIND THE SCENES
The Highly Logical Location of Set Location

It took me quite a while to gain an appreciation for the Set Location command. In fact, for months it seemed like a stumbling block.

In early alpha releases of Space Simulator, the Set Location command was the first item listed on the Location menu. As we explored the menu's features, many of us often chose this command by mistake simply because it was at the top of the menu, only to then realize that we weren't interested in an ultra-specific location but wanted the more general choices offered by the other commands.

I was relieved to hear Patrick Wilkinson, our lead tester, admit one day that he had been tripping on it also. Patrick has an incredibly logical state of mind, reminiscent of Mister Spock on the original Star Trek *television series. This must have made me the impassioned Doctor McCoy: "Jon, this is clunky! You simply can't have the users stumbling on Set Location every time they want to fly to a new planet!" Patrick's agreement on this was like having Spock nod, lift his eyebrows, and tell the captain, "It* is *highly illogical."*

One day Jon Solon, in his role as Captain Kirk, decided that the Location menu would indeed be a friendlier place if Set Location were moved to the bottom of the list. Small modifications like this were always being made, adding up, one by one, to what I consider a pretty sweet interface.

▲ ▲ ▲

MISSION: Mining the Asteroids

On this mission, you'll get to act out one of the great science fiction story lines from pulp magazines of the 1940s and 1950s: traveling to an asteroid for a mining expedition. We'll go to Cybele, the smallest of our solar system's asteroids to appear in Space Simulator, with a diameter of only 246 kilometers. To get closer to the asteroid, we'll use the Set Location dialog box rather than choosing the Asteroids command from the Location menu.

Launching a Mining Expedition to Cybele

1. Choose the Spacecraft command from the Flight menu. In the dialog box, select Zander Freighter and choose OK. This huge ship seems like the best spacecraft to take on a mining operation. But if you have another favorite ship, you can just as easily take off in it.
2. Choose the Set Location command from the Location menu. In the Set Location dialog box, choose the Base Object button.
3. In the Select Base Object dialog box, select Asteroids from the Object Type list. Then select Cybele from the list of asteroids and choose OK to close the dialog box. The Set Location dialog box reappears, with Cybele as the current base object.
4. Set the latitude for 005 00 00, and then select the North option button, placing your spacecraft at a latitude just 5 degrees north of the asteroid's equator, or center line. (You can set any latitude that does not exceed 90 degrees. Feel free either to experiment or to simply use the existing settings.)
5. Set the longitude for 150 00 25, and then select the East option button. (You can set the longitude to any value that does not exceed 360 degrees.)
6. Set an altitude of 30 kilometers, which brings you 330 kilometers closer to the asteroid than you would have been if you had simply used the Location menu's Asteroids command. (Be sure that you select the Altitude button, not the Distance button; otherwise, you'll end up inside the asteroid, which will be hard on both you and your ship.)
7. In the Update section, leave the Reference Object option checked so that Cybele will become the new reference object. Turn off the Tracking Object check box.
8. When you have completed your settings in the Set Location dialog box, choose OK. You are now 30 kilometers above the surface of Cybele, 5 degrees above its equator.
9. You might need to yaw your spacecraft left or right if it isn't facing the asteroid. If Cybele isn't well lit when you arrive there, choose the time display. In the Time dialog box, set the time for 09:30:00 and the date for 09 Oct 2002.



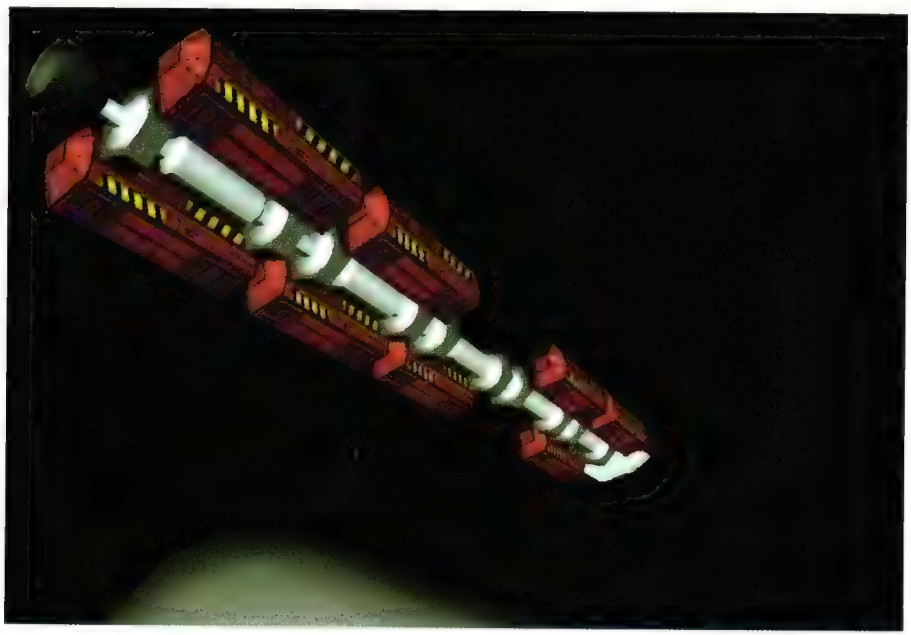


SPACECRAFT CLOSEUP

The Zander Freighter is the largest ship in Space Simulator's fleet, with a mass of 100,000 metric tons and a length of 1,100 meters. Its nuclear fusion engines can produce 2 Gs of thrust, and its fuel reserves are so vast that it can produce maximum thrust for 634 years before refueling. Like all of Space Simulator's ships, it carries an All Terrain Lander and a manned maneuvering unit.

10. Switch to Chase view so that you can see the Zander Freighter in orbit above Cybele.
11. To see your craft turn while Cybele remains still, change the chase craft perspective to absolute by pressing the B key. Pressing B again restores the relative chase craft perspective, which means that the chase craft will turn along with your ship (a clunkier way of flying).
12. Choose the Deploy Lander command from the Flight menu to launch the All Terrain Lander, leaving the Zander Freighter in stationary orbit above the asteroid.
13. Fly the All Terrain Lander to the surface of Cybele, and land for a closer look. If you're flying with your skill level set for Intermediate or Advanced, you'll need to reduce your velocity to just a few meters per second for the landing.
14. Choose the Space Walk command from the Flight menu. In the manned maneuvering unit, you can take an even closer look at the asteroid. Along the way, you might want to switch to a full-screen view of what is happening.

Enjoy your explorations of Cybele. Any time you like, you can return to the Set Location dialog box, choose a different object to visit, and then set off on another adventure, experimenting with all the adjustments the dialog box offers.





8

SAVING YOURSELF WITH SITUATIONS

One afternoon in February of 1994, Jon Solon flagged me into his office, closed the door, and said, "I'm going to show you something that rates a 10 on the coolness scale."

Jon went to Space Simulator's Options menu, chose the Open Situation command, and then opened FORCHRIS, a situation named for Chris Lassen, a manager in Microsoft's Consumer Division, who had been watching as Jon created this you-are-there epic.

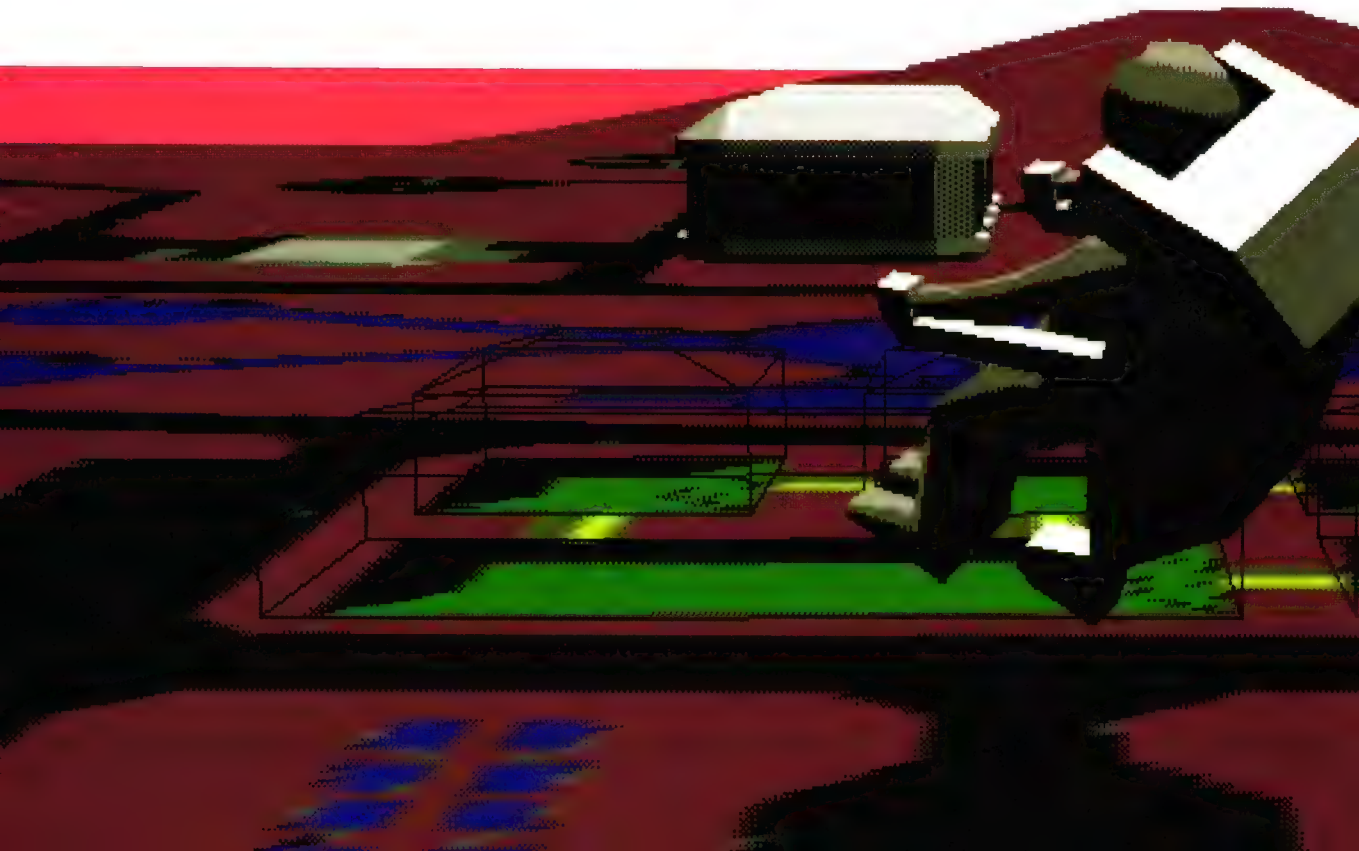
The screen opened with the red sky and red terrain of Mars. Immediately you felt a sense of floating, almost falling, as the manned maneuvering unit swept down from a tower in one corner of Mars Base Marineris and smoothly glided toward the greenhouses on the ground below.

Then with his joystick Jon applied turns and arching descents so gracefully that you were sure you were there, in the air, flying just above the rooftops of Mars Base Marineris, out of reach of anyone on the ground, but prankishly low, as if you were buzzing the place on a joyride and, if caught, would certainly have some explaining to do, and perhaps some extra hours of duty assigned in the base's oxygen plant or waterworks.

When Jon's demonstration was over, I had just one request: "Can I have a copy of the situation?"

Getting a copy of someone's situation is like getting an invitation into that person's world. You can experience for yourself whatever your friend has created or found, and then you can take off on a riff of your own, using that situation as a springboard into yet another adventure, yet another world.

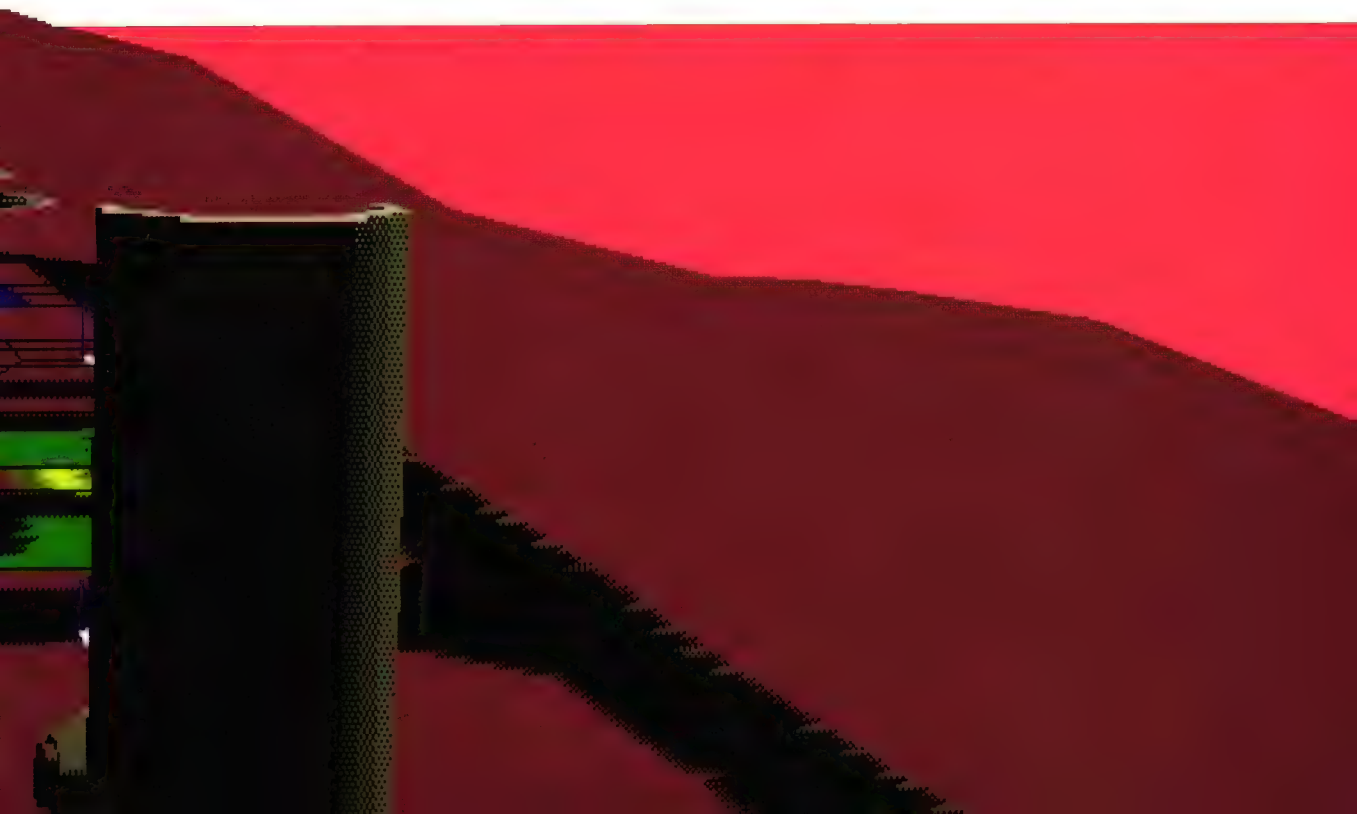
You're going to love the ability to save your situations and go diving back into them. In this chapter, you'll see how this can enhance your enjoyment of Space Simulator.



Saving the Situation

By now, you're familiar with the Options menu's Open Situation and Save Situation commands. You've used the Open Situation dialog box to launch new adventures, and you've learned to value the Save Situation dialog box as a safety net, in case you want to restart a situation from a point other than the beginning. But just what goes into the making of a situation?

When you create and save a situation, Space Simulator stores everything that is going on in the program at that moment. When you reopen this situation, you find yourself in the same spacecraft at the same location in space. All the settings you used for the view tools, the instrument panel displays, the autopilot, and the flight computer are the same. In other words, once you save a situation, you will always be able to reopen it and re-create exactly what was happening at the time you saved it.



The Open Situation Dialog Box

For such a powerful tool, the Open Situation dialog box has a simple and straightforward design. To gain an appreciation of what you can do with it, let's briefly examine its features.



As you know, the File Name list contains the names of available situations. When you select a name from the list, the Directory box tells you which directory contains the situation file. (A single dot in the Directory box indicates that the situation is saved in your Space Simulator directory.)

The Description box provides information about where you'll go and what you'll see if you open that situation. Descriptions accompany all the situations shipped with Space Simulator, and you'll want to add your own descriptions when you create new situations.

As usual, you open a selected situation by choosing the OK button when you're ready. To close the dialog box without opening a situation, choose the Cancel button instead.

If you have trouble navigating through your File Name list because it is too long, you'll be happy to know that you can limit the clutter by using the filtering mechanism in the Show section of the Open Situation dialog box. By default, all four filters are open (all four check boxes are checked), meaning that all existing situations appear in the File Name list. To exclude a particular category of situations from the list, simply turn off the check box for that category.

The Flight Situations category includes situations created during spaceflight. If the Observatory Situations category is turned on, any observatory-based situations you created are also included in the File Name list. The Product Situations category displays in the list those situations that ship with Space Simulator. To add situations that you've personally created (either in spaceflight or at the observatory) to the list, be sure to turn on the My Situations category.

For example, if you develop a large collection of your own situations, you can turn off Product Situations and see a list that contains only the situations you created yourself. If you also turn off Observatory Situations, leaving only Flight Situations and My Situations selected, the list contains only the situations you created while in spaceflight.

Using the Show filters can temporarily prevent a set of situations from being displayed in the File Name list, but it does not remove those situations from Space Simulator. If you'd like to delete a situation permanently, select the situation name, choose the Delete button, and then confirm the deletion in the small dialog box that appears. (Note that Space Simulator won't let you delete any of the built-in situations.) There's no need to leave Space Simulator and go out to MS-DOS to do your housecleaning.

Finally, the Startup Situation section of the Open Situation dialog box allows you to choose the situation that will appear as the startup screen when you start Space Simulator. You can pick your favorite built-in situation so that it's the first sight you see whenever you fire up the program, or you can create a special situation to give Space Simulator a "custom" feel. You'll learn exactly how to change the startup screen later in this chapter.



TECH TIP

Use the Reset Situation command from the Options menu to relaunch your current situation. For example, if you are docking your ship with a space station and make a piloting error that you don't want to spend time recovering from, choose Reset Situation (or press Ctrl-Esc) to restart the docking situation.



TECH TIP

As a shortcut, you can display the Save Situation dialog box by pressing the semicolon (;) key.



TECH TIP

Use the Save Situation command as the ultimate bookmark. If you're in the midst of a long journey or a complicated mission and must bail out of Space Simulator for a while to deal with the real world, save your situation so that you can pick up later exactly where you left off.

The Save Situation Dialog Box

The Save Situation dialog box is one of my favorite parts of Space Simulator. As you can see, it closely resembles the Open Situation dialog box, although it is even simpler and more straightforward.



In the box above the File Name list, you'll see the name of the situation that is highlighted in the list. To enter a new name for the situation you're saving, use the Backspace key to erase the current name and then type the new name—as usual, no more than eight characters—in the box. (Don't worry about the name you erase; you can't delete a situation unless you use the Delete button in the Open Situation dialog box.)

By default, situations are saved in your Space Simulator directory, and you don't need to add anything to the Directory box. But if you'd like to save a situation in a different directory, type the directory pathname in this box, using standard MS-DOS naming conventions.

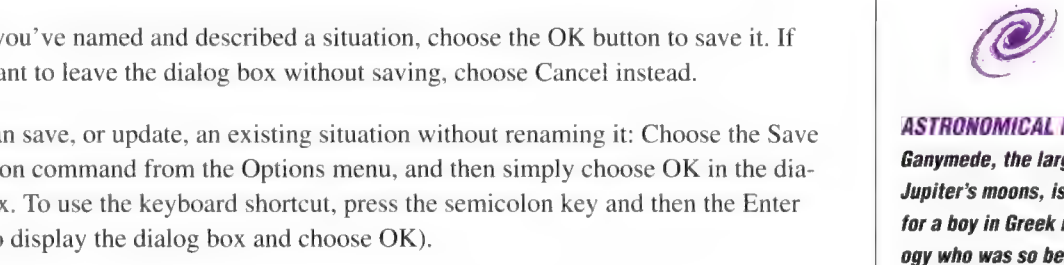
Before you save a situation, it's a good idea, plus a lot of fun, to enter some information in the Description box. Your description can be as long as 250 characters and can range from the technical to the whimsical. Then, as you scroll through the

File Name list (in either the Open Situation or Save Situation dialog box), you're able to read about each situation you've created. The descriptions help you build a personal library of easily identifiable situations.

After you've named and described a situation, choose the OK button to save it. If you want to leave the dialog box without saving, choose Cancel instead.

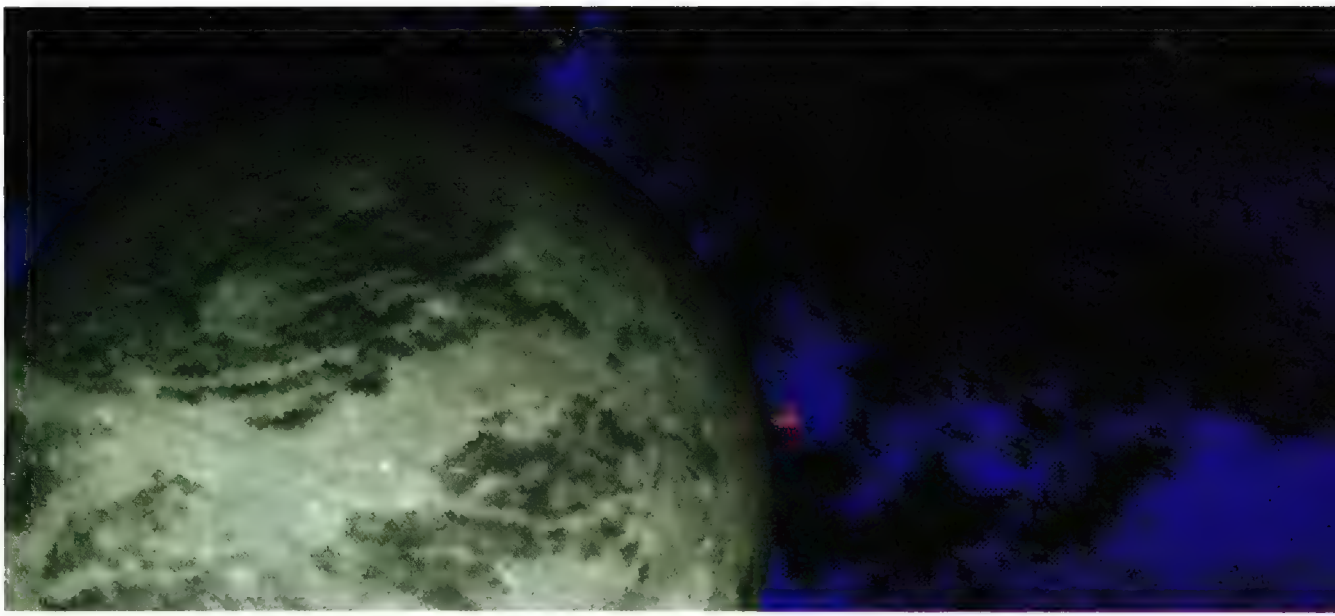
You can save, or update, an existing situation without renaming it: Choose the Save Situation command from the Options menu, and then simply choose OK in the dialog box. To use the keyboard shortcut, press the semicolon key and then the Enter key (to display the dialog box and choose OK).

When you embark on a long journey that requires frequent saves, try choosing a filename that contains only seven letters, leaving an eighth character available for numbering the saves. For example, if you were flying to the moon Ganymede, you might name the initial situation GANYMED. Then you can name subsequent saves along the way GANYMED1, GANYMED2, GANYMED3, and so on. This naming scheme makes it easy for you to resume the journey at various points.



ASTRONOMICAL NOTE

Ganymede, the largest of Jupiter's moons, is named for a boy in Greek mythology who was so beautiful that Zeus, king of the Greek gods, changed himself into an eagle so that he could swoop down and carry Ganymede off to Mount Olympus to serve as cup bearer to the gods.



Jupiter's moon Ganymede

Creating Outstanding Situations

It's after midnight, Wagner's "Ride of the Valkyries" is playing on the FM, and I'm running Space Simulator on three different machines. On a 486/66, I'm flying in a situation I call CANALS!, mapping the exotic canal-like features of Alpha Centauri's eighth planet. On an old beater IBM PS/2 70 is a Jon Solon situation in which the MMU is gliding past Ring Station 1, with the Whirlpool galaxy vast and magnificent in the background. And on a never-say-die Compaq 386/20e, the Galactic Explorer passes in front of the Lunar Orbiter, a great ship leaving port and heading out into the deep void.

Why run Space Simulator on three machines at once? Just for the fun of it, I suppose, in the same way that it's fun to collect situations from others. It's exciting to venture through a new situation, and it's always interesting to see how different people create different experiences.

Jon Solon, who has flown the full-size MMU trainer at NASA's Johnson Space Center in Houston, often flies the MMU into dramatic situations. Patrick Wilkinson, the testing lead, sometimes looks up an occultation or planetary positions in astronomical texts and then enters the exact time, date, and location into Space Simulator to see how closely reality is matched on screen. And others just seem swept away by the experience of being in space, eager to document what they've found, via Save Situation, to show to friends. Saving an exciting situation is like going on a solo expedition into uncharted country and then returning to the leather and mahogany comfort of some Explorers' Club to share your experiences.

The secret of creating great situations is simple: Go out exploring, and choose Save Situation whenever you happen upon something that captures your fancy. Do it both for yourself and for others. Capturing your experiences in Space Simulator is like journalizing, recording your own adventures from your travels through unexplored worlds.







SPACECRAFT CLOSEUP

Named for American physicist Robert Bussard, the Bussard Ram-Jet is second in size only to the Zander Freighter, with a length of 400 meters. The large magnetic funnel at its front scoops in hydrogen as fuel for its fusion engines. The ship's maximum acceleration is only 2 Gs, but once up to speed, its fuel supply is effectively unlimited, making it an excellent choice for interstellar passages.

Building from Existing Situations

An excellent way to begin creating situations is to bootstrap off existing situations. Using the list in the Open Situation dialog box, scroll through the situations that ship with Space Simulator, and find one you like. Open it, and begin making adjustments. Whenever you find an interesting effect, just press the semicolon key, give the situation a new name, and choose OK. As you customize an existing situation, it becomes your own.

You can begin with any situation. Let's make a quick change in FLIGHT, the familiar opening situation.

Creating a New Situation Based on FLIGHT

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. Choose the Location button to cycle to Chase view so that you can see your spacecraft, the Galactic Explorer.
3. Press the B key to set the chase craft perspective to absolute. Earth and Ring Station 1 disappear from view.

4. Press Shift-keypad 6 or use the horizontal panning bar to bring Earth and Ring Station 1 back into your line of vision.
5. Choose the Spacecraft command from the Flight menu. In the dialog box, select Bussard Ram-Jet and choose OK. I've always liked the looks of this spacecraft, but you can choose any craft you like.
6. Press the left arrow key or use your joystick to turn the spacecraft toward Ring Station 1, making the scene more dramatic.
7. Press the keypad slash key a few times to rotate the spacecraft, and press keypad 5 to stop rotation. The solar panels on the Bussard Ram-Jet look great at an angle.
8. Adjust the panning bars until you have exactly the view you want. You can also apply thrust and use the rotation keys to reposition your spacecraft in relation to Earth and Ring Station 1.
9. Press the W key to switch to Full Screen view.
10. Choose the Save Situation command from the Options menu. In the dialog box, type the name you want to use for your situation. For example, you could call it MYOPENER or even name it after a pet cat or dog (as long as the pet's name doesn't contain more than eight letters).
11. In the Description box, type information that will help you recognize the situation later. You can include any sort of description—for instance, "The Bussard Ram-Jet arrives at Ring Station 1, the place I'm sending the cat if it doesn't stop clawing up the furniture."
12. Choose OK. The deed is done! You've now created and saved the situation.

Changing the Startup Situation

You can put your personal stamp on Space Simulator by using a situation you've created as your opening situation. Or perhaps you'd prefer to begin with another of the built-in situations occasionally instead of always seeing FLIGHT. It's easy to change the startup situation:

1. Choose the Open Situation command from the Options menu. In the dialog box, select the name of the situation you want to use as a startup.
2. Choose the Select button. The name of the new startup situation appears above the button.
3. Choose OK.

The next time you start Space Simulator, it will immediately go to the startup situation you've designated.

You can change startup situations as often as you like. Whenever you want to restore Space Simulator's original startup screen, just select the FLIGHT situation in the Open Situation dialog box, choose the Select button, and then choose OK.



Using Situations to Return to Places Fast

Saving a situation and then reopening it enable you to do what you want where you want, without repeating preliminary setups such as choosing a new location, selecting a different spacecraft, adjusting the View Controls dialog box, and so on. In short, situations just make life easier for space travelers.

If you want to conduct a survey of the alien solar systems found in Space Simulator (by "alien," I mean those planets orbiting stars other than our own), you could set up a series of situations—for instance, one situation for each planet of the star Arcturus. Otherwise, you'd first have to choose the Stars command from the Location menu, select Arcturus in the dialog box, and choose OK. Then, after arriving at Arcturus, you'd have to reopen the menu, choose the Planets command, and decide which planet you want to visit. And you'd need to repeat this process for each visit. By creating and saving a series of situations, you perform such setup procedures only once.



With a situation like FORCHRIS, described at the beginning of this chapter, all you need to do is open the situation—and you are already at Mars Base Marineris, flying with the MMU, with your velocity established. Anytime you want, you can have yourself airborne over the Martian base with just a couple of clicks in the Open Situation dialog box.

FORCHRIS eventually evolved into a situation named MMU-MARS, which you'll find in the list of situations that ship with Space Simulator. But for those of you who might like a behind-the-scenes glimpse of this evolution, here's how FORCHRIS was originally created.

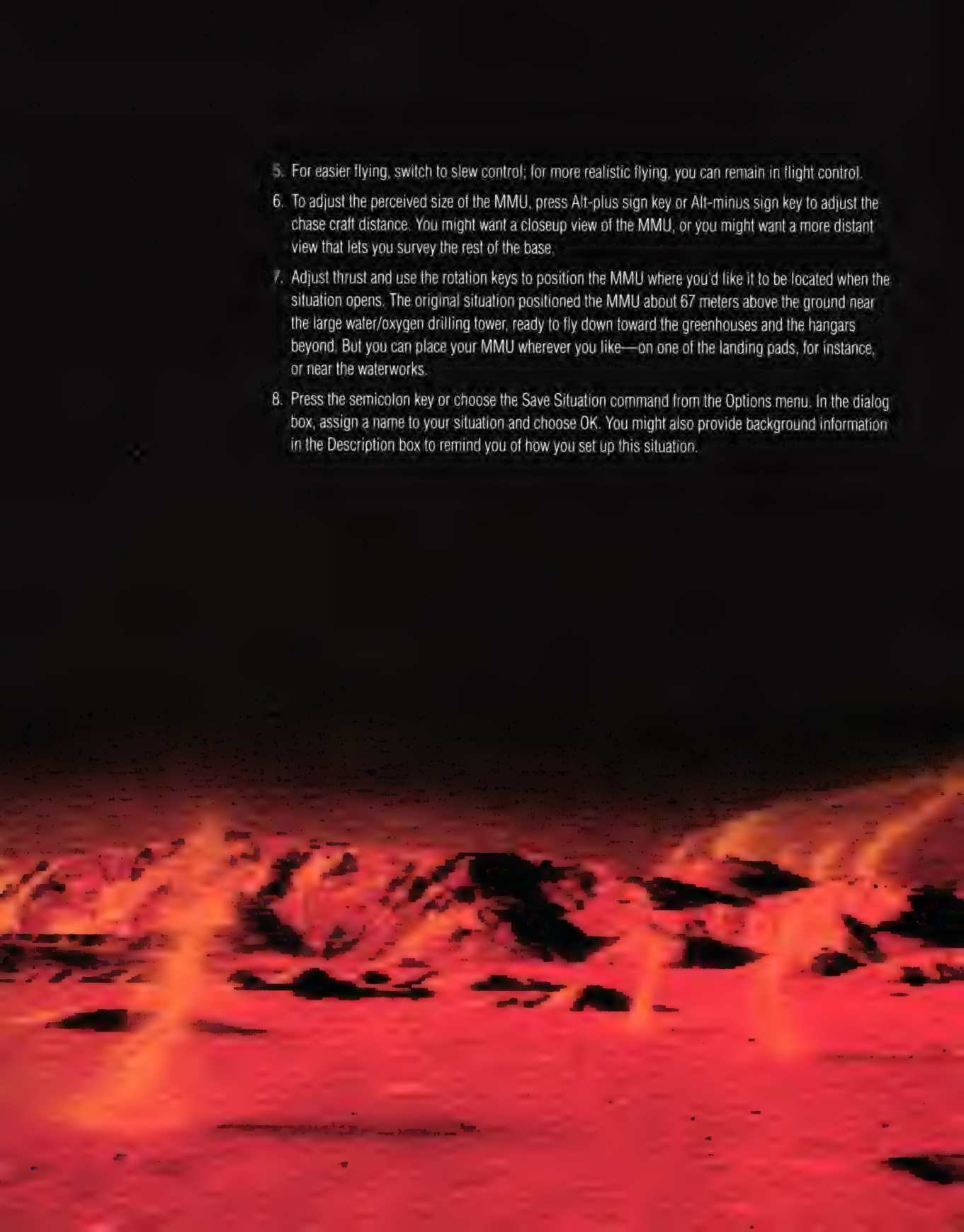
Creating FORCHRIS

1. Choose the Surface command from the Location menu. In the dialog box, select Mars Base Marineris and choose OK.
2. Choose the Spacecraft command from the Flight menu. In the dialog box, select Manned Maneuvering Unit and choose OK.
3. Choose the Location button to cycle to Chase view.
4. Press the B key to use the absolute chase craft perspective.

"In contrast to Venus, which is highly inhospitable to life as we know it, we believe that Mars is an alternative home for humanity."

Pioneering the Space Frontier: The Report of the National Commission on Space

5. For easier flying, switch to slew control; for more realistic flying, you can remain in flight control.
6. To adjust the perceived size of the MMU, press Alt-plus sign key or Alt-minus sign key to adjust the chase craft distance. You might want a closeup view of the MMU, or you might want a more distant view that lets you survey the rest of the base.
7. Adjust thrust and use the rotation keys to position the MMU where you'd like it to be located when the situation opens. The original situation positioned the MMU about 67 meters above the ground near the large water/oxygen drilling tower, ready to fly down toward the greenhouses and the hangars beyond. But you can place your MMU wherever you like—on one of the landing pads, for instance, or near the waterworks.
8. Press the semicolon key or choose the Save Situation command from the Options menu. In the dialog box, assign a name to your situation and choose OK. You might also provide background information in the Description box to remind you of how you set up this situation.



ASTRONOMICALLY SPEAKING
The Martian Oasis

Mars might some day become a magnificent oasis and rest stop for interplanetary missions. Scientists believe that locked within its polar ice caps, and perhaps also sitting within frozen soil beneath its surface, is that precious commodity, water.

Though it will be water and other life-sustaining essentials that will attract humans to Mars, visitors will also behold some spectacular sights. Mars boasts an enormous volcano, Mons Marineris, which is three times taller than Mount Everest. And the planet's colossal canyon, Valles Marineris, would stretch from one coast of North America to the other, swallowing up Earth's Grand Canyon so completely that it would be lost in the void and jumble.

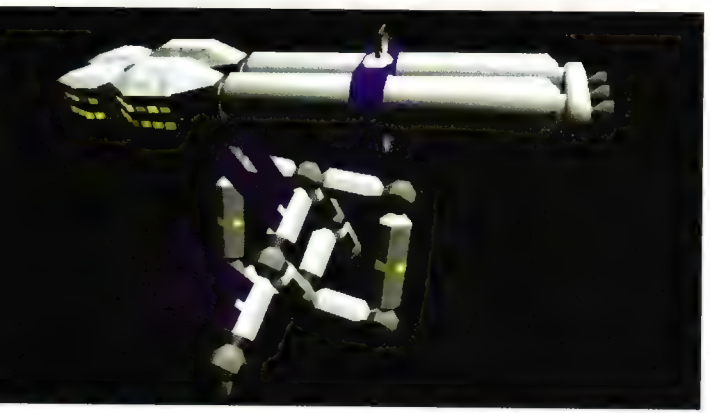
"Television images from robot spacecraft orbiting Mars found vast erosional features, quite possibly formed by the swift flow of liquid water. If so, Mars must once have been far warmer and wetter than it is now."

—Pioneering the Space Frontier: The Report of the National Commission on Space



Making Good Use of the Tracking Object

Here's a situation I created specifically so that I could see my spacecraft travel onto the screen, across the screen, and then off the screen. As you've noticed by now, Space Simulator (like Flight Simulator) by necessity keeps your spacecraft seemingly stationary as all of space comes moving toward you. If you could watch your spacecraft move forward while in Chase view, it would forever be traveling off the screen.



Still, I thought it would be intriguing to actually see my ship move against the background objects. To accomplish this, I chose Chase view and designated the Lunar Orbiter rather than my spacecraft as the tracking object. I backed my spacecraft off the screen (using slew control), canceled all thrust, and then added forward thrust just before saving this as the FLYABOUT situation. The result is that shortly after you open the situation, the Galactic Explorer comes lumbering across the screen.

Creating the FLYABOUT Situation

1. Choose the Space Stations command from the Location menu. In the Update section of the dialog box, be sure that both the Reference Object and the Tracking Object check boxes are turned on. (The settings for the reference object and the tracking object are important elements of creating this situation.) Select Lunar Orbiter and choose OK to move to this space station.
2. Switch to absolute chase craft perspective.
3. Choose the Location button to cycle to Chase view, and adjust the horizontal panning bar so that you can see your spacecraft with the Lunar Orbiter in the background. Note that when you shift from Cockpit or Assigned view to Chase view, your spacecraft automatically becomes the tracking object.
4. Press the T key to display the Select Tracking Object dialog box. Select Space Stations from the Object Type list, select Lunar Orbiter, and choose OK to restore the Lunar Orbiter as your tracking object.
5. Press Alt-minus sign key until you see your spacecraft in the foreground.
6. Press the left arrow key (or use your joystick or mouse) to rotate the spacecraft so that it appears lengthwise across the front of your screen. This orients your spacecraft so that you can back it off the screen. The front of your ship should face the left side of the screen, and the tail of the ship should face the right side.

7. To make flying a little easier, switch to slew control.
8. Press Shift-keypad minus sign six times to slowly back your spacecraft away from the space station. Normally the space station would appear to back away.
9. About 5 seconds after your spacecraft disappears off the left of your screen, press F5 to stop its movement. If you didn't switch to slew control, be sure to press F4 also, to cut all residual velocity.
10. To make the situation more dramatic, switch to Full Screen view, hiding the instrument panel and the view tools.
11. Press the semicolon key to display the Save Situation dialog box. In the File Name box, type the name you want to assign to this situation, and describe the situation in the Description box. Choose OK.
12. Press keypad plus sign six times, and then immediately press the semicolon key again and choose OK. In this step, you apply thrust and then immediately resave the situation before your spacecraft reappears on the screen. Your saved situation is updated with thrust applied.

Enjoy the show as your spacecraft slowly emerges from the left side of the screen and flies toward the Lunar Orbiter. If you would like to apply more speed, press keypad plus sign again.

ASTRONOMICALLY SPEAKING
Mining on the Moon

The Moon will certainly be an early magnet for orbiting space stations such as the Lunar Orbiter as well as for surface colonies. The great industry on the Moon will be mining—extracting metals, minerals, and other materials that don't have to be blasted out of Earth's strong gravity. Soil samples returned by the U.S. Apollo missions indicate that the Moon contains about 20 percent silicon, 12 percent aluminum, 4 percent iron, and 3 percent magnesium. All of these are great building and industrial materials, which could be removed from the far side of the Moon without scraping and mangling the face that is shown to Earth.

The greatest treasure, however, will be oxygen, the precious but common element that is chemically locked up within the rocks and soil of the Moon, just as it is on Earth. A bountiful 40 percent of lunar soil can be in the form of oxygen, just waiting to be harvested so that humans can breathe.



Flying Circles Around the Tracking Object

While playing around in the FLYABOUT situation, I stumbled on an exciting aspect of the program that let me experience Space Simulator in an even more realistic way. Initially, I created FLYABOUT for the striking view of the spacecraft on a slow flyby against the backdrop of the Lunar Orbiter. As I experimented with the situation, I discovered the joy of flying my ship *around* the Lunar Orbiter.

Making Space Simulator Seem Even More Real

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLYABOUT (or whatever name you assigned to the situation created in the preceding section) and then choose OK.
2. Choose the Spacecraft command from the Flight menu. In the dialog box, select All Terrain Lander (or another spacecraft you want to fly) and choose OK. I enjoy flying a smaller ship when I'm traveling near a space station.
3. Use the rotation keys, the joystick, or the mouse to change the direction of your spacecraft as it comes onto the screen.
4. Press Alt-plus sign key to keep your craft in view as it heads away from you and toward the Lunar Orbiter. This helps you to experience Space Simulator in a new way, as you try to keep your ship from flying off into space out of view.
5. Continue to use the rotation keys, the joystick, or the mouse as you pilot your ship clear around the Lunar Orbiter. You can also vary your velocity, but be careful not to lose track of your spacecraft.
6. If you do lose sight of your craft, press the T key. In the Select Tracking Object dialog box, select Spacecraft from the Object Type list, select the name of the ship you're flying, and choose OK. Your spacecraft comes back into view as it becomes your new tracking object.

The more I fly this way—using Chase view but without designating my spacecraft as the tracking object—the more I like it. On your next circuit around the Lunar Orbiter, try to pilot your ship through one of the two center squares formed by the design of the space station. You can also try increasing your velocity, again while keeping your spacecraft in view. Remember that you can press Alt-plus sign when the spacecraft gets too far from you and Alt-minus sign when the ship is heading back toward you. If you wind up too far away from the Lunar Orbiter, choose the Reset Situation command from the Options menu.

BEHIND THE SCENES
A Passion for Perfection

Something that helps to make each situation in Space Simulator special is the precision with which the orbital mechanics are programmed. When you've landed on one of Saturn's moons, for instance, watching the other moons do their orbital dance, the motion you see, even with the time scale jacked up, is exactly how the planets, moons, and other objects actually travel.

This wasn't easy to accomplish. I once asked Charles Guy what made the motion equations so difficult. His answer: "Math and physics with machine language."

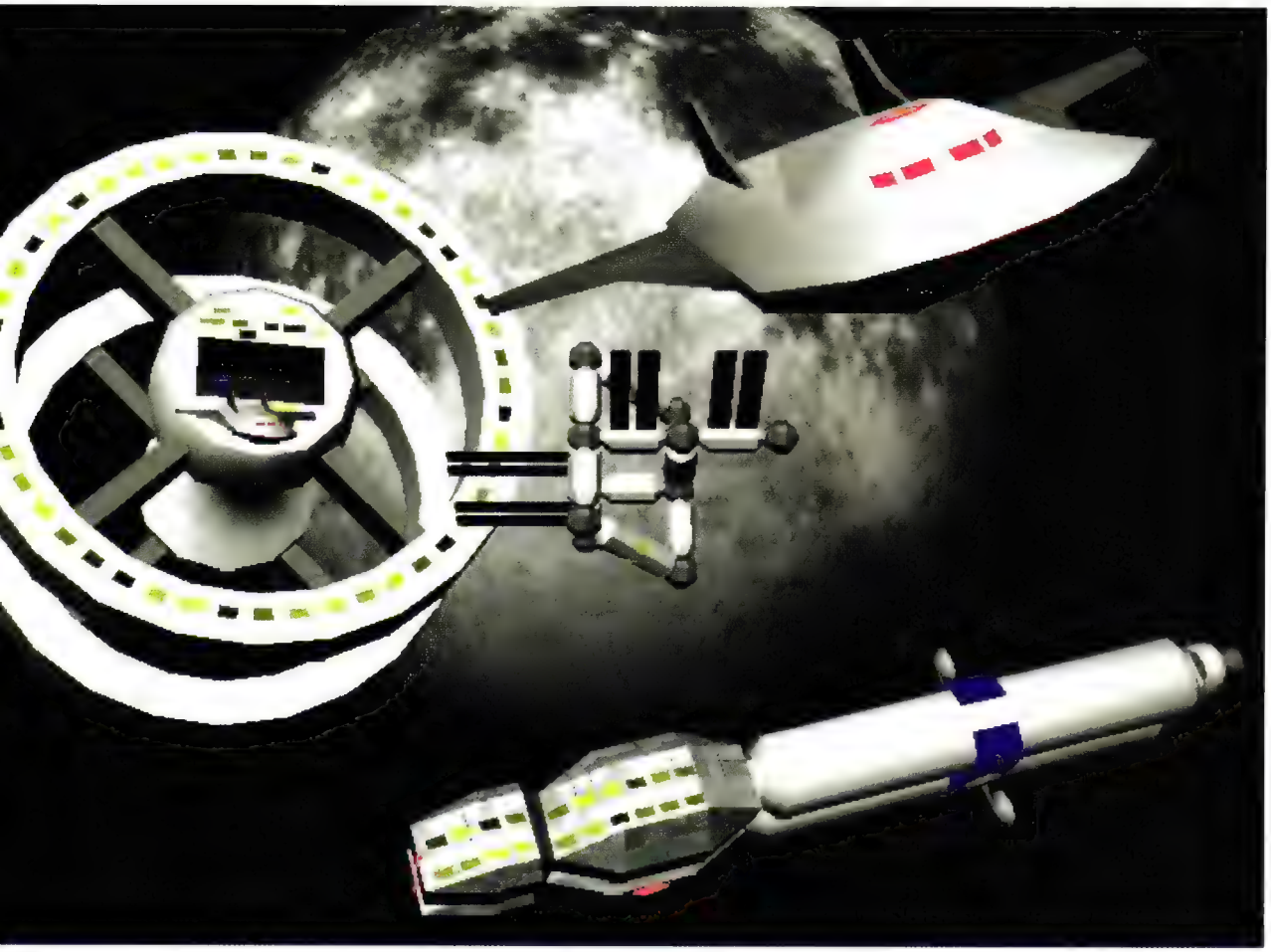
His passion for perfection seems driven by a passion for what he is trying to simulate. Looking through a telescope one night at two of Ursa Major's galaxies, M81 and M82, Charles described them as "absolute beauties." And as we took turns viewing the spectacular Double Cluster in Perseus, Charles spoke of the stars as if they were charming young humans just setting out in life.

"They're brand-new," Charles said of the stars. "They just condensed out of the hydrogen soup. They are hot, young, new stars, and they're trying to make a name for themselves. They're drifting away, leaving their birthplace. They're going out and getting a job."

Creating a Very Busy Sky

I enjoyed playing with FLYABOUT so much that I decided to create a new situation, BUSYSKY, just to see how many objects I could crowd onto one screen, creating a playground in space where I could go flying around. The goal was to fly either the MMU or the ATL with a nearby space station or idle spacecraft set as the tracking object rather than the ship I was piloting, to see myself flying in the most realistic way.

This became another of those wonderful experiences in which I seemed to fall into the world of Space Simulator, as if I were Alice tumbling down the rabbit hole into Wonderland. I started my expedition at about ten o'clock one night and didn't stop until nearly six o'clock the next morning. Along the way, I created something that hadn't been done before with the program: I positioned two space stations and three spacecraft together on the same screen. It was great fun—and several times it was even tense. By the time you've created your own version of BUSYSKY, you'll have accomplished some feats in Space Simulator that you might not have thought possible.



MISSION: Building Your Own Playground

Get ready to muster up some ingenuity—and a little patience!—as you start constructing a personal playground in space. Once you've saved this situation, you'll be able to return to it whenever you like, to play like a kid in a junkyard as you fly from one spacecraft or station to another.

The procedures for creating BUSYSKY offer a challenge that might seem to break the rules of Space Simulator. Fortunately, however, there *are* no rules in Space Simulator—in other words, if you can make it happen, it was meant to be so!

Creating BUSYSKY

1. Choose the Open Situation command from the Options menu. In the dialog box, select FLIGHT and choose OK.
2. Cycle to Chase view, and set your chase craft perspective to absolute. Then dock the Galactic Explorer with Ring Station 1. (For more information on docking, see "MISSION: Docking with Ring Station 1," in Chapter 5.)
3. Choose the Vehicle Transfer command from the Flight menu to transfer your control from the spacecraft to the space station you've docked with. Now you will be flying Ring Station 1.
4. Choose the Space Stations command from the Location menu. In the dialog box, select Lunar Orbiter and verify that the Tracking Object option is checked. Choose OK. This step is one of the secret ingredients. Suddenly you have transported not only your spacecraft but an entire space station to the neighborhood of the Lunar Orbiter.
5. Using thrust and rotation, maneuver Ring Station 1 into whatever location you want. You can do this in flight control, but it's certainly easier with slew control. I decided to place Ring Station 1 in the background because it is so much larger than the Lunar Orbiter.
6. Choose the Vehicle Transfer command from the Flight menu to transfer yourself from Ring Station 1 back to the Galactic Explorer. Then choose the Undock command from the same menu.
7. Fly the Galactic Explorer into position. You might want to bring the ship to the foreground, to create a bigger object to play around with and also to help with the next steps, which involve deploying landers.
8. Choose the Deploy Lander command from the Flight menu. Your control automatically shifts to the lander when it is deployed, so you don't need to choose the Vehicle Transfer command.
9. Fly the All Terrain Lander into position on the screen. In LUNAR26, I placed the ATL in the foreground because of its small size in comparison to the two space stations and the Galactic Explorer.
10. Choose the Deploy Lander command from the Flight menu, and fly this second ATL back toward Ring Station 1. There you have it: two space stations and three spacecraft, all on one screen!
11. Now the fun begins, as you fly the second All Terrain Lander around this scene. You can see your spacecraft turn and move about the unchanging backdrop in a very lifelike manner because the Lunar Orbiter is your tracking object.



TECH TIP

As you create BUSYSKY, save the situation several times as you progress. I originally called this situation LUNAR26, and as I developed it, I did incremental saves, from LUNAR1 to LUNAR26. Frequent saves are good insurance; later on, you can delete the earlier versions you don't want.



TECH TIP

As a shortcut, you can press Shift-D to deploy the lander.

12. Press Alt-plus sign and Alt-minus sign to vary the chase craft distance. You can also press the plus sign and minus sign keys on the main keyboard to adjust the magnification of the scene.
13. If the view of your spacecraft becomes too small as you fly toward Ring Station 1, press the T key. In the Select Tracking Object dialog box, select the Spacecraft option button. Then select the second All Terrain Lander (the one you are currently piloting) and choose OK.
14. Save the final situation with the name BUSYSKY (or another name of your choice).

Having Fun on the Playground

The beauty of a situation such as BUSYSKY is that once you've created it, you can return to it whenever you like. For instance, you might enjoy revisiting the scene in the MMU. Because so many spacecraft are active on the screen, you'll have to retract one of the All Terrain Landers before setting off on your space walk.

Flying the MMU in the BUSYSKY Situation

1. Choose the Open Situation command from the Options menu. In the dialog box, select BUSYSKY (or the name you gave the situation) and choose OK.
2. Choose the Retract Lander command from the Flight menu. This command removes one of the All Terrain Landers from the screen, leaving the Galactic Explorer, one ATL, and the two space stations. You can launch the MMU only when fewer than three spacecraft are displayed on the screen.
3. Choose the Space Walk command from the Flight menu to have the manned maneuvering unit emerge from the All Terrain Lander.
4. For a larger image of the MMU, which makes it easier to pilot, press Alt-plus sign to decrease the chase craft distance.



TECH TIP

As a shortcut, you can press Shift-W to launch the MMU and begin a space walk.

Have fun! You've got a great playground to fly in—it sure beats the void of interstellar space!

Whenever you want to change the tracking object, use the Select Tracking Object dialog box. Generally, you should try to keep the tracking object set for whatever is nearest the MMU. For example, if you fly the MMU toward the Galactic Explorer, make that ship your tracking object. If you fly the MMU to Ring Station 1, set the station as your tracking object. And when you're traveling between objects, make the MMU your tracking object so that you can keep it centered on your screen.

Now try using what you've learned to create your own playground, making sure to save each situation so that you can return. Remember that the situations you create can be your private doorways into a unique way of experiencing Space Simulator. Situations are like secret passages and hidden corridors that you create in the product to rapidly go wherever you want and to seamlessly begin whatever you want to do.

BEHIND THE SCENES
A Fearful Number of Stars

Sometimes while flying in situations that took me toward the core of our galaxy, I'd recall what Charles Guy once told me about being frightened by the sheer vastness of the galaxy.

When he was fifteen years old, he was sitting on a dock in Minnesota one night beneath an exceptionally dark and clear sky. He looked toward Sagittarius, which is near the core of the Milky Way galaxy. "What I saw was so intense that it frightened me," Charles remembered. "I had to look down at the ground. It was too much. Slowly, I built up the nerve to look at it more and more with my naked eyes. And eventually, I got to the point where I couldn't stop looking at it. I became more and more obsessed with it. To this day, I'm still trying to make models of the Milky Way galaxy."

In describing his fear, Charles said, "The scale of it was frightening to me. I felt like I was standing on a pinpoint, oppressed by the size of this thing. It really did frighten me, but I found that this fear really isn't like normal fear. It is the kind of fear that is respectful, although it becomes a fear that must be conquered and resolved. It leads toward growth and understanding."

▲ ▲ ▲

"Space provides us with an endless frontier: an endless supply of new places to explore, new adventures, new things we have never seen before, new sources of joy, perhaps even new sources of fear."

—Frank Drake, astronomer



9

USING THE AUTOPILOT AND THE FLIGHT COMPUTER

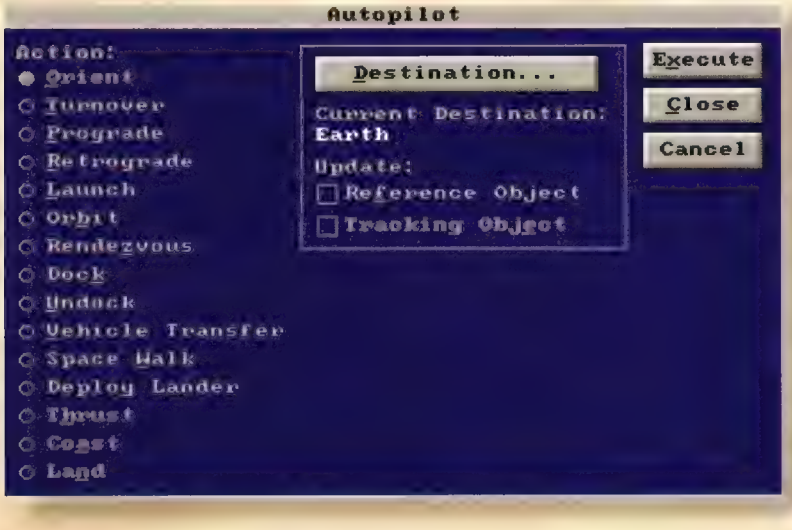
I was flying Space Simulator one night while talking long distance to Charles Guy. (He was in Champaign, Illinois, and I was in lunar orbit.) It was easy to talk to him as I sat at my controls, because Space Simulator's flight computer was executing a flight plan I had created the night before.

Although the reputation of spaceship computers became a tad tarnished after the film debut of the terribly misunderstood HAL 9000 in the Arthur C. Clarke–Stanley Kubrick classic *2001: A Space Odyssey*, they are actually quite helpful and well intentioned, practically shouting, "Trust me!"

Space Simulator's autopilot and flight computer are no exceptions. The autopilot can execute 15 piloting actions, from orienting your ship and applying thrust to entering an orbit or landing at a specified destination. And the flight computer allows you to group individual autopilot actions into completely automated flight plans.

The Autopilot: No Ship Should Be Without One

To begin using Space Simulator's autopilot, choose the Autopilot command from the Flight menu. In the Autopilot dialog box, you can design and automate specific actions that can streamline your spaceflights. Here's a brief survey of what the autopilot can do for you.



- **Orient:** Points your ship toward a destination you specify.
- **Turnover:** Turns your spacecraft by 180 degrees, reversing its direction, which is especially useful as you prepare to apply braking thrust.
- **Prograde:** Aligns the front of your ship with the current direction of travel. If you have turned your ship sideways in space without applying new thrust, your direction of travel hasn't changed. So before you apply new thrust, it's a good idea to choose the Prograde action to ensure that the thrust is applied in the direction you want.
- **Retrograde:** Aligns the front of your ship so that it is facing opposite the current direction of travel. You can then apply thrust to slow your ship or lower its orbit.
- **Launch:** Launches your spacecraft from the surface of an object into an orbit of specified radius and azimuth.
- **Orbit:** Pilots the ship from any point in space into an orbit around a destination you specify.



TECH TIP

Several autopilot actions—Launch, Dock, Undock, Vehicle Transfer, Space Walk, and Deploy Lander—duplicate commands from the Flight menu. They are available in the autopilot so that you can include them in flight plans you create with the flight computer.



- **Rendezvous:** Steers your craft through space to the destination of your choice and places the ship on a course parallel to that of the destination object.
- **Dock:** Flies your ship to a space station or another spacecraft and performs all the necessary docking maneuvers—positioning and aligning the ship, applying thrust, and so on.
- **Undock:** Undocks your craft from a space station or another ship.
- **Vehicle Transfer:** Transfers your control from your own ship to the space station or other craft with which you've docked. Selecting this action again transfers control back to your original ship.
- **Space Walk:** Launches the manned maneuvering unit.
- **Deploy Lander:** Deploys the All Terrain Lander.
- **Thrust:** Applies full thrust for a specified duration.
- **Coast:** Allows your ship to coast for a specified duration. In the vacuum of space, your craft will coast with the same velocity it had before you canceled thrust.
- **Land:** Lands your spacecraft at a destination you specify.



TECH TIP

You can cancel an autopilot action in progress by pressing Z or choosing the autopilot display on the instrument panel to toggle the autopilot off.

You can select any one of these 15 actions from the list in the Autopilot dialog box. Then, to have the autopilot carry out the selected action right away, simply choose the Execute button, and the autopilot takes over. (If you change your mind and don't want to execute the selected action, choose the Cancel button instead, which closes the dialog box without saving or performing an action.)

If you don't want the action performed immediately, choose the Close button, which closes the dialog box but saves the action for the autopilot to carry out later. When you're ready to execute the action, just press the Z key or choose the autopilot display on the instrument panel to turn on the autopilot and perform the action. (You can save only one autopilot action at a time with this method; to save more than one action for later, you'll need to use the flight computer, described later in this chapter.)

Whichever action you select, the Autopilot dialog box lets you be as specific as you need to be. For example, many autopilot actions are linked to a specified destination, an orbital distance, or an event duration.

BEHIND THE SCENES
Is the Autopilot Alive?

A conversation with Charles Guy shortly before Space Simulator was completed made me look at the flight computer and the autopilot with new eyes. "When we got servo actions into the autopilot, it began to appear as if it had a life of its own," Charles commented.

The term "servo actions" refers to the feedback loop built into the autopilot. As the autopilot carries out an action, it constantly monitors velocity and position to measure its progress against the plan. Sometimes a spacecraft seems to shake as it reacts to this feedback loop.

"When I see the spacecraft shake and tremble, it strikes a chord in me," Charles said. "I've worked with artificial intelligence and neural networks, and it seems as if this might be something like the way neuron networks operate. The spacecraft is sometimes jerky, but it is purposeful. For instance, when the autopilot does obstacle avoidance [such as avoiding Jupiter when traveling from one Jovian moon to another], it is doing what I tell it to, but I'm incapable of performing these instant calculations. I'd crash. Somehow it seems organic when it is avoiding something. In guiding the spaceship, the autopilot is adapting to changes, adapting to the planets spinning around, adapting to the area in which it's hanging out. That's why I think of it as being alive—because it is adapting."

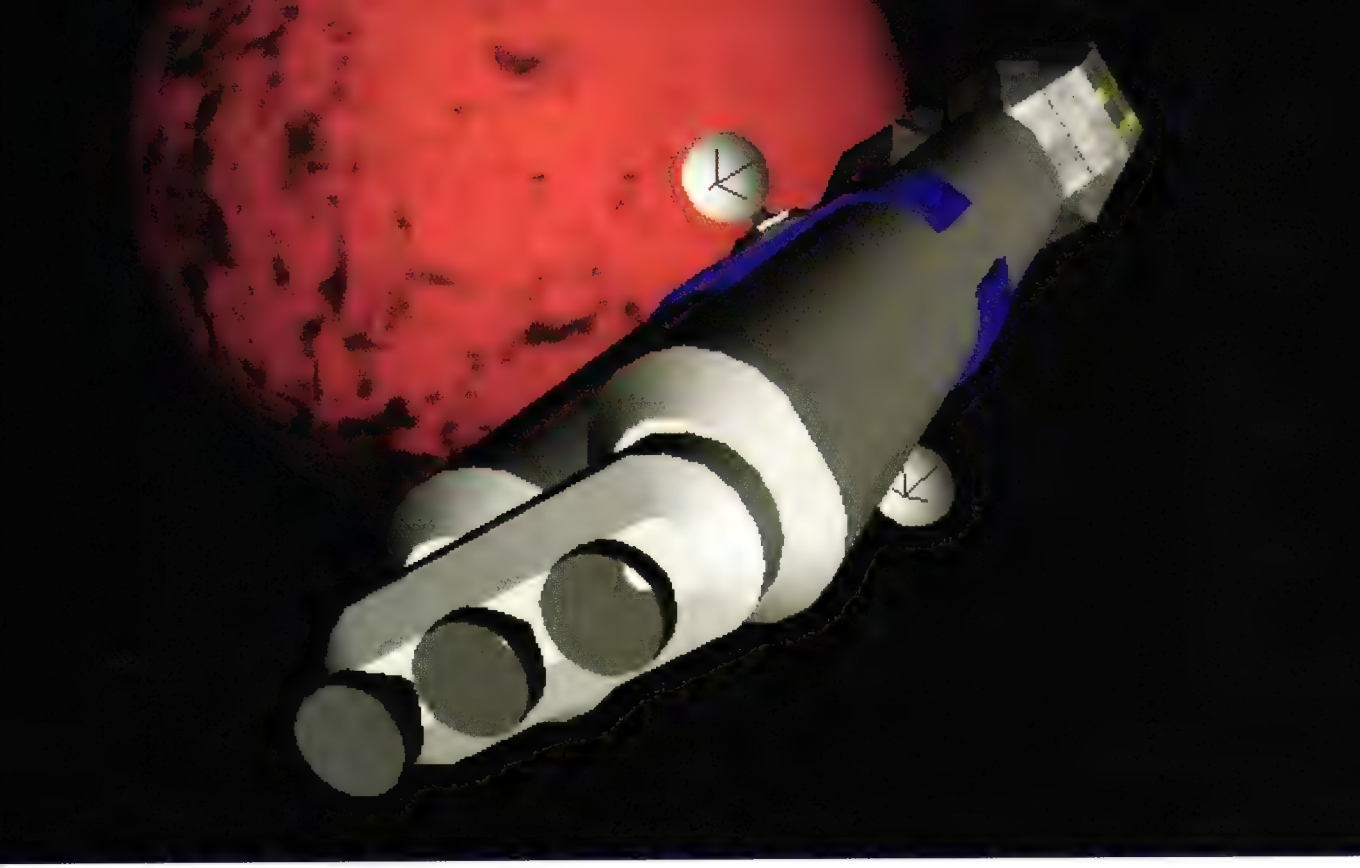


Destination

Seven autopilot actions—Orient, Prograde, Retrograde, Orbit, Rendezvous, Dock, and Land—can be carried out only when you link the action to a destination. When you select one of these seven, the Destination button appears in the Autopilot dialog box. Choose this button to display the Select Destination Object dialog box, where you can set your destination.

This dialog box works just like others you've used in Space Simulator: Select an option button in the Object Type list, select a specific destination from the list box, read the information in the Description box, and choose OK.

In the section below the Destination button in the Autopilot dialog box, you have the opportunity to make the chosen destination your reference object, your tracking object, or both. If you don't want to do this, turn off the Reference Object and Tracking Object check boxes in the Update section.



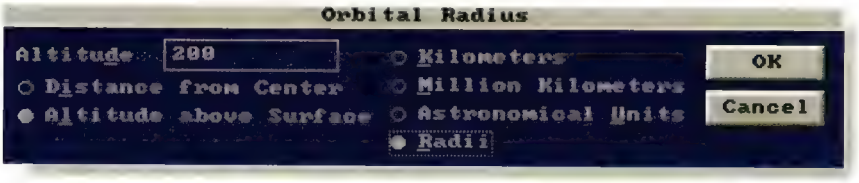
The autopilot can take your ship to Mars with hardly any effort on your part.

The autopilot is simple and logical. For example, if you want to point, or orient, your ship toward Mars, select Orient as your autopilot action, choose the Destination button, and use the Select Destination Object dialog box to set Mars as your destination. When you choose the Execute button in the Autopilot dialog box, the autopilot turns your spacecraft in the direction of Mars. Add some thrust, and you're off to the red planet.

Let's say that on the way to Mars you've rotated your ship to take in the sights. If you want the autopilot to realign the craft with your destination (your current direction of travel), you can execute the autopilot's Prograde action, with Mars set as your destination. Or if you want to apply a retroburn to slow your progress toward Mars, the autopilot's Turnover action rotates your spacecraft so that your great engines are facing toward Mars and any thrust you apply slows you down in reference to the planet.

Orbital Radius

When you select the Launch or the Orbit autopilot action, you'll see a button called Orbital Radius in the Autopilot dialog box. Choosing this button opens the Orbital Radius dialog box.



In this dialog box, you select whether you want the orbital radius to be measured as distance from the center of the object you're orbiting or as altitude above the object's surface. Then enter a specific value for the distance or the altitude, select a unit of measure—kilometers, million kilometers, astronomical units, or radii—and choose OK. For example, if you are on the surface of Mars, you can open the Autopilot dialog box, select Launch, and then use the Orbital Radius dialog box to set an orbit 150 kilometers above the surface of the planet. If you don't specify an orbital radius, Space Simulator defaults to an orbit with an altitude of 300 kilometers.

Below the Orbital Radius button in the Autopilot dialog box, you can also set a launch azimuth (measured in degrees) by entering a number between 0 and 360. (The default setting is 90 degrees.) Azimuth is a measurement of direction. Due north is defined as 0 degrees; as you turn clockwise, the azimuth reading increases, reaching 360 degrees when you are facing north again. So, for example, if you want to head for an object's north pole, you would set an azimuth of 0 degrees. The default setting of 90 degrees points you east, a setting of 180 degrees moves you south, and a setting of 270 degrees launches your ship toward the west.

When you select the Orbit action, you'll also see an Orbital Inclination box that lets you set a custom orbit. (This box isn't displayed when you select Launch.) An orbital inclination of 90 degrees, the default value, places your spacecraft in a perfect polar orbit. If you change the orbital inclination to 0 degrees, for instance, the autopilot places you in an equatorial orbit. You can set this value for any number between 0 and 90.

Event Duration

When you select the Thrust or Coast action, choose the Duration button. In the Event Duration dialog box, you specify how long the application of thrust or the coasting should last, by typing a value and then selecting a unit of measure—seconds, minutes, hours, days, months, or years. You can use decimal fractions when entering this value; for example, you could specify a thrust duration of 0.5 second or a coasting duration of 1.832 years.



Enjoying the Precision of the Autopilot

You'll soon be using the autopilot as comfortably as if it were a dashboard radio—choose a few buttons, and enjoy the precision and automation with which it performs each action. When you want to head out for new territory, just open the Autopilot dialog box, select Orient, set your next destination, and choose Execute. Before you know it, your spacecraft will be pointing exactly where you want to go.

The autopilot is great for changing orbits, too. You can use the Orbit action not only to fly to a new destination and establish a stable orbit but also to adjust your orbital height. For example, if you set an initial orbit of 3 radii, you could use the Orbit action to place yourself in a higher orbit of 7 radii or to adjust your orbit downward to just a few hundred kilometers above the surface.



The ATL undocks from the Galactic Explorer and prepares to land on an asteroid.



TECH TIP

For complicated actions, the autopilot must control the time scale, and you'll often be unable to speed up or slow down the passage of time. During simpler actions, such as Coast and Thrust, you can adjust the time scale.

With the Rendezvous action, you can have a lot of fun poking around objects you want to explore, such as a comet, an asteroid, or a moon. Rendezvous brings you onto a parallel course with the object you've set as your destination rather than placing you in an orbit around it. You can then adjust your position relative to the object and perhaps deploy the lander or go spacewalking with the MMU for a closer look. If your rendezvous is with a smaller object such as an asteroid or a comet, select the Land action after you arrive, and let the autopilot take you in for a landing so that you can do super closeup explorations. Feel free to treat the autopilot as a toy: Experiment and have fun with it!

BEHIND THE SCENES
Creating the Autopilot and the Flight Computer

Because flying in space is so complicated, it had always been apparent that Space Simulator would need some sort of autopilot. "Seat-of-the-pants flying in space is difficult," Charles Guy said. "Whether you're talking about flying over a period of months or conducting a maneuver that must be timed to a tenth of a second, piloting in space is a task that's very appropriate to have a robot perform for you."

Nearly every spacecraft that's been launched has depended on some kind of automated system. "Look at the space shuttle," Charles continued. "When the shuttle is launched, what's being executed is all a pre-programmed flight plan. The pilot's main duty is to monitor readouts, confirm that systems are working, and make changes if necessary. But in general it's highly desirable to have all the burns fully automated."



ASTRONOMICAL NOTE

The Magellan space probe was launched from a space shuttle in 1989. In 1990 Magellan began transmitting radar images of the planet Venus to Earth, allowing scientists to see through Venus's thick shield of clouds.

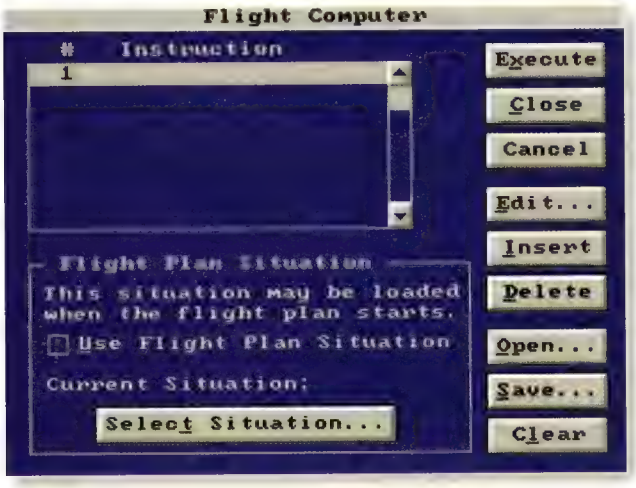
Once the need for Space Simulator's autopilot was established, the value of a flight computer quickly became evident. "The flight computer seemed like a natural outgrowth of the autopilot, as a way to allow a natural sequence of autopilot events to happen," Charles explained. "I read a lot about computerized flight plans. With the Magellan probe, for instance, mission control would typically download a flight plan several hours before it was needed for the next maneuver and verify it. Then, when the time came, the spacecraft would execute the program."



A space shuttle launch is only one of the actions that can be automated with Space Simulator's autopilot and flight computer.

The Flight Computer: Your Robotic Copilot

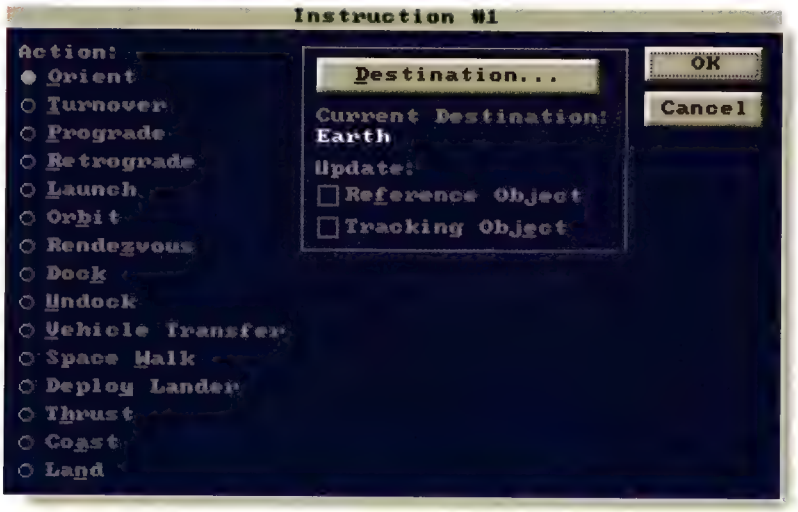
The autopilot by itself is pretty amazing, but it is the flight computer that really lets you kick into gear with great explorations, allowing you to easily assemble individual autopilot instructions into a complete flight plan of whatever complexity you choose. The flight computer is like having a robotic copilot at your side during your travels. To open the Flight Computer dialog box, choose the Flight Computer command from the Flight menu.



"There was a flare of blow-back jets as the thing executed a landing that would have killed a human pilot, and then a weird creaking as it readjusted its articulated carbon-fiber airframe. Turner could make out the green reflected glow of instrumentation in the curve of the plastic canopy."

—William Gibson, *Count Zero*

The Instruction box in the Flight Computer dialog box is where you construct the basic outline of your flight plan, assembling the autopilot actions, or instructions, in the order you want. To start creating a flight plan, select one of the numbered instruction lines and choose the Edit button, which lets you add or change an instruction. Choosing this button opens a numbered Instruction dialog box; for example, if you select line 1 in the Instruction box and choose Edit, you'll see the Instruction #1 dialog box (which is similar to the Autopilot dialog box).



In the numbered Instruction dialog box, select one of the 15 autopilot actions; provide any necessary information about destination, orbital radius, or event duration; and choose OK. When you return to the Flight Computer dialog box, the selected action now appears in the Instruction box.

As you develop your flight plan, you can also use the Insert, Delete, and Clear buttons in the Flight Computer dialog box. Choose Insert to insert a new instruction into an existing flight plan; choose Delete to remove a selected instruction from the plan. Choosing Clear erases all the instructions in the current flight plan and lets you start over.

If you want to use a favorite situation as the starting point of a flight plan, turn on the check box marked Use Flight Plan Situation. Then choose the Select Situation button, and select the situation. When you tell the flight computer to take over, it loads the situation you specified and starts executing the first instruction.

When you finish working on a flight plan, choose the Save button and use the Save Flight Plan dialog box to save the list of instructions as a complete flight plan that you can reopen whenever you like. To open a flight plan you've saved, choose the Open button in the Flight Computer dialog box, select the name you assigned to the flight plan, and choose OK.

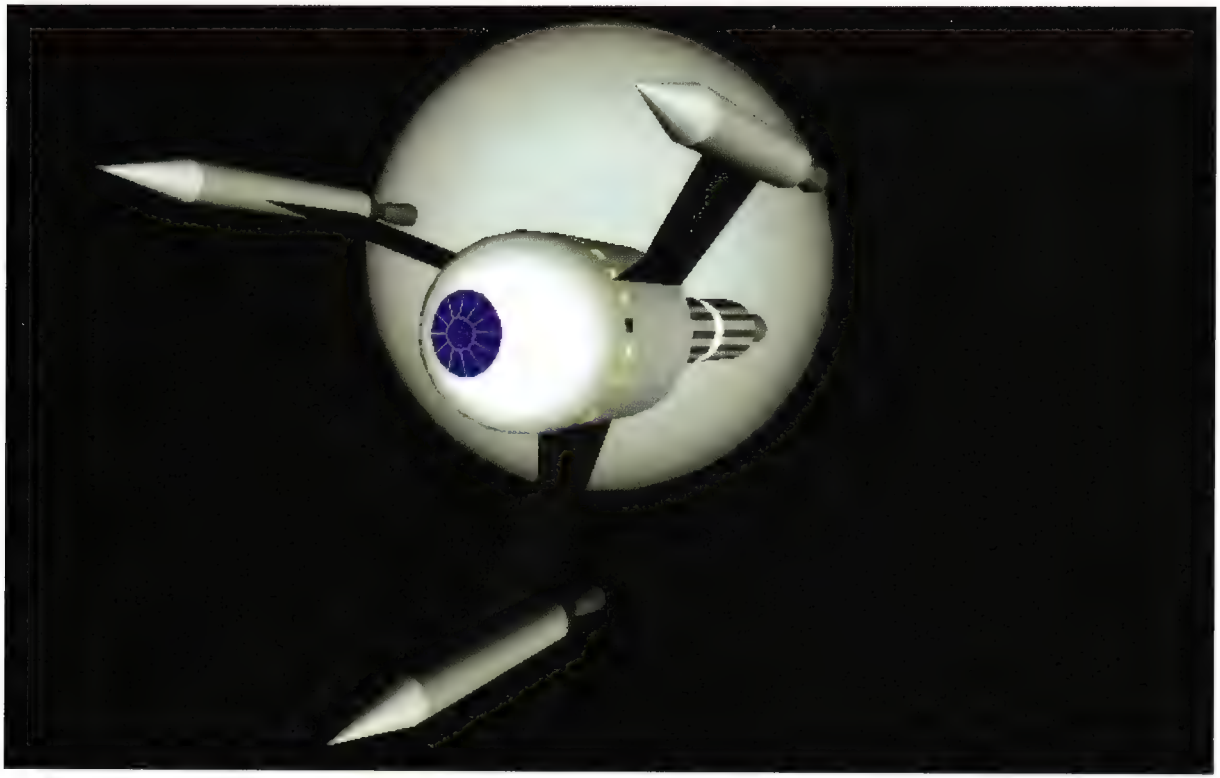
To have Space Simulator begin executing the current flight plan right away, choose the Execute button in the Flight Computer dialog box. If you'd rather close the dialog box and store the flight plan for later use, choose Close. (Keep in mind, however, that if you exit Space Simulator without saving your flight plan, the flight plan will simply evaporate!) Choosing the Cancel button will close the dialog box—and cancel any changes you made.

Creating Wondrous Voyages with the Flight Computer

Assembling flight plans with the flight computer can set your imagination soaring across the galaxy and beyond. When you plan the stages of your expedition, you more fully appreciate the vastness of space and the immense amounts of time required to fully explore it—at least for those without a time scale or a time machine. As an example, let's put together a quick trip around the inner solar system.

MISSION: A Quick Trip Around Our Solar System

As you begin to assemble custom flight plans, it's enjoyable to make use of your own backyard—that is, astronomically speaking, our solar system. This mission takes you out to some of our nearest neighbors. After you've gotten as far as these instructions take you, you can continue to build on the flight plan to expand the tour of our neighboring planets. There's a lot to see!



The Callisto breaks free from its orbit around Mercury and heads toward a rendezvous with Venus.

Getting Your Trip Started

1. Choose the Flight Computer command from the Flight menu. In the Flight Computer dialog box, select line 1 in the Instruction box. You're ready to enter your first instruction.
2. Choose the Edit button to display the Instruction #1 dialog box.
3. In the Action list, select Orbit, and then choose the Destination button. In the Select Destination Object dialog box, set Mercury as your destination by selecting Planets from the list of object types and selecting Mercury from the list box. Choose OK. Back in the Instruction #1 dialog box, select the Reference Object and Tracking Object options in the Update section so that you can monitor your progress toward the planet.
4. Choose the Orbital Radius button, and set an orbit with an altitude of 4 radii above the surface. Choose OK to close the Orbital Radius dialog box. Then choose OK in the Instruction #1 dialog box to return to the Flight Computer dialog box. The Orbit autopilot action is now the first instruction in your flight plan. Mercury, the planet nearest the Sun, is set as the action's destination.

5. Select line 2 in the Instruction box, and choose the Edit button. In the Instruction #2 dialog box, select Rendezvous and then set Venus as the destination, just as you set Mercury as the destination in step 3. Choose OK to close the Select Destination Object dialog box.
6. In the Instruction #2 dialog box, select the Reference Object and Tracking Object options in the Update section so that your instrument panel displays will be refreshed for the new destination. Choose OK. When you return to the Flight Computer dialog box, Rendezvous is the second instruction of your flight plan, with Venus as its destination.
7. In the same manner, edit line 3 in the Instruction box so that it becomes an instruction to orbit the planet Mars.
8. Oops! You missed a planet between Venus and Mars. You'll need to go back and insert Earth into your flight plan. (You could land if you like, but for now, you can plan to simply orbit.) Select line 3 in the Instruction box, and choose the Insert button. The Orbit instruction that previously appeared in line 3 moves to line 4. The Insert button lets you place a new flight instruction between the trip to Venus and the trip to Mars.
9. With the new blank line 3 selected, choose the Edit button. In the Instruction #3 dialog box, select the Orbit action and choose the Destination button. In the Select Destination Object dialog box, select Planets and then select Earth. Choose OK, and then set the orbital radius for an altitude of 600 kilometers above the surface. Choose OK to close the Instruction #3 dialog box. In the Flight Computer dialog box, a new instruction appears on the third line of your flight plan: the Orbit action, with the destination now set for Earth.
10. Choose the Save button. In the Save Flight Plan dialog box, type a name for the flight plan and choose OK. You might want to use the name TRIP1.
11. Choose the Execute button.



The Callisto passes near Venus.

Sit back and enjoy the voyage as the automated flight plan for TRIP1 takes over. Be sure to use tracking mode for your view so that you don't miss anything along the way. And if you've chosen to update the tracking and reference objects with each step, the flight computer updates them for each leg of the journey; you'll begin by tracking Mercury and then move on to track Venus, Earth, and Mars. (And by the way, don't worry if Mercury looks a little odd. Half of its surface appears perfectly smooth in Space Simulator, but that's only because the surface maps were unavailable and the developers decided not to fake it.)



TECH TIP

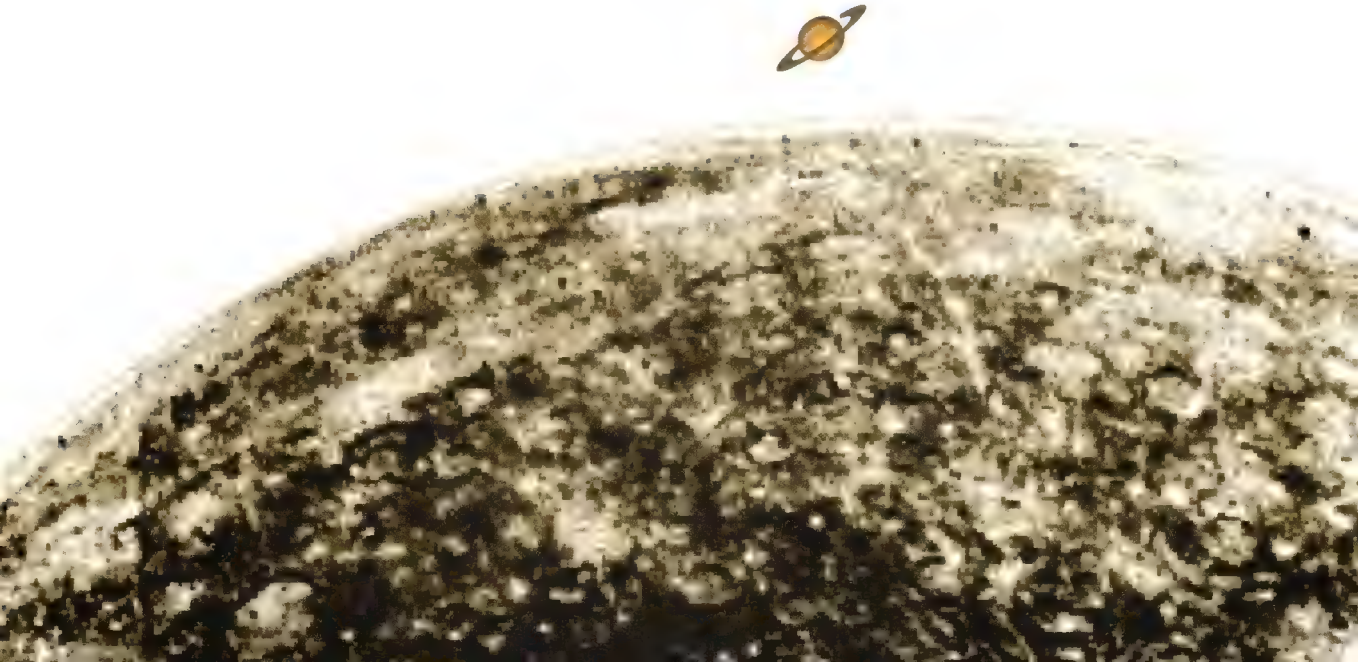
When you're executing a flight plan, it's a good idea to use tracking mode rather than panning. Otherwise, you might enter an orbit or arrive at a rendezvous without seeing your destination (depending on where your cockpit window is facing). If you'd like to experiment with your view, however, you can set View 1 for panning (or even for Map view) and View 2 for tracking.

Now try reopening TRIP1 and using the Insert button to add a Coast action between each existing action. The coasting durations can be as long or as short as you want. I like to include coasting as a brief break between the more active autopilot actions. Save this modification as a separate flight plan, with a name such as COASTER1.

ASTRONOMICALLY SPEAKING
Mercury and Its "Snowballs in Hell"

Temperatures on Mercury, the planet closest to the Sun, reach 800 degrees Fahrenheit at the planet's equator. So it was front-page news in May 1994 when astronomers announced that they had confirmed the existence of ice in the planet's polar regions. Finding ice on Mercury is like finding "snowballs in hell," David Paige, professor of planetary science at UCLA, told the *Los Angeles Times*. Researchers used new high-resolution radar maps to identify lakes of ice within polar craters that provide permanent shadow to protect the ice from the Sun's heat.

The discovery of ice—and hence water—on Mercury (of all places!) boosts scientists' hopes that ice reserves might exist on our Moon and elsewhere. In fact, the plucky little spacecraft Clementine found polar craters on our Moon that are also in permanent shadow. Do they contain water? When humans begin to create colonies in space, water will be one of the most precious resources. Finding it already available on planets and moons should make it easier for humans to move into space.



Building on an Existing Flight Plan

Over time, you can use the flight computer to build your own library of flight plans. Whenever you develop a flight plan you really like, just choose the Save button and give the plan a name to make it part of your permanent collection. Creating a library of flight plans does more than keep wonderful adventures handy; it also provides building blocks for creating even more interesting and complex expeditions.

To illustrate, let's build on TRIP1, the flight plan you created and saved in the preceding section. The new flight plan will contain eight individual autopilot actions, linked to automate a single voyage.



TECH TIP

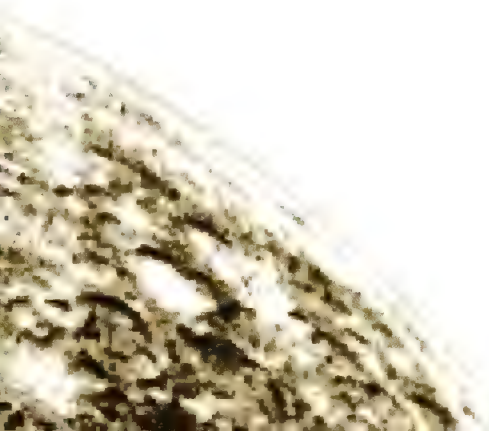
How many autopilot instructions can you load into a single flight plan? The flight computer is designed to accept as many instructions as you care to assemble—hundreds if you like. And because the flight computer continually reexamines its position relative to the destination object, loading vast flight plans won't cause cumulative errors.

MISSION: Flying a Space Station to the Stars

You can add a new stop to your existing TRIP1 flight plan (or to COASTER1, for that matter) by including a visit to Ring Station 1. Your crew will thank you . . . at least until they wake up and discover that they are now in orbit around Alpha Centauri!

Building on TRIP1

1. Choose the Flight Computer command from the Flight menu. In the Flight Computer dialog box, choose the Open button. In the Open Flight Plan dialog box, select TRIP1 from the list of flight plans and choose OK. The flight computer is now open, with the flight plan TRIP1 displayed in the Instruction box. You can add more autopilot instructions to the flight plan or alter any of the existing instructions.
2. Select line 4, which is currently set for Orbit, and choose the Delete button. When the flight computer asks you to confirm that you really want to delete the instruction, choose OK.
3. With line 4 selected, choose the Edit button. In the Instruction #4 dialog box, select the Deploy Lander action and choose OK. In the Flight Computer dialog box, Deploy Lander is now the fourth instruction of your growing flight plan.





4. Select line 5, which should be blank, and choose the Edit button. In the Instruction #5 dialog box, select the Dock action and choose the Destination button. In the Select Destination Object dialog box, select the space station Ring Station 1 as your destination. Then choose OK. Select the Update Reference Object and Tracking Object options, and choose OK to complete the instruction. In the Flight Computer dialog box, the fifth instruction of your flight plan now calls for docking with Ring Station 1.

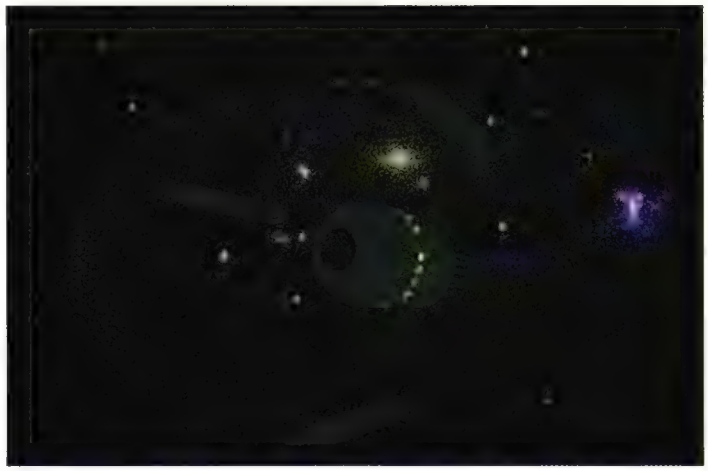
5. Select line 6, and choose the Edit button. In the Instruction #6 dialog box, select Coast and choose the Duration button. In the Event Duration dialog box, set a duration of 2 minutes. Choose OK in both dialog boxes. Coasting, now your sixth instruction, is useful for simply "hanging out" before the flight computer goes on to the next instruction. In this case, you'll spend 2 minutes docked to Ring Station 1 before the flight plan moves to the seventh instruction.
6. Select line 7, and choose the Edit button. In the Instruction #7 dialog box, select Vehicle Transfer and choose OK. This seventh instruction transfers your control from your spacecraft to Ring Station 1. Accordingly, the next flight instruction will apply to the space station.
7. Select line 8, and choose the Edit button. In the Instruction #8 dialog box, select Orbit and set the destination for the star Alpha Centauri. Yes, you'll be flying both your ship and the space station to this star.
8. In the Instruction #8 dialog box, choose the Orbital Radius button and set an orbit for an altitude of 20 million kilometers above the surface. Choose OK twice to return to the Flight Computer dialog box. (If you want to add a ninth instruction—or even more—just scroll down to the next blank line in the Instruction box.)
9. Choose the Save button. In the Save Flight Plan dialog box, type a name for this flight plan, add a description of where the flight takes you, and choose OK. You might want to call this flight plan TRIP2. By giving it a name other than TRIP1, you'll have both the original and the extended versions of the flight plan available in your library of flight plans.



TECH TIP

To clean out unwanted flight plans, exit Space Simulator. At the system prompt, type the MS-DOS command DEL, followed by a space and the filename of the flight plan (including its filename extension, .PLN). To see a complete listing of all your flight plans from MS-DOS, enter the DIR command followed by a space, an asterisk, and the .PLN extension.

The flight computer allows you to think in truly galactic terms, providing a thrilling sense of being a Captain Picard, a Han Solo, or another traveler from the world of science fiction. You can formulate a flight plan that will take you on a mining expedition, methodically moving from one asteroid to the next. You can construct a plan that will carry you to each planet in our solar system and let you visit all of the planet's moons before you head out for the next stop. Or you might want to go calling on the various space stations, docking at each one and then going for a space walk.



Cloaked in interstellar darkness, the Callisto speeds away from the Milky Way.



TECH TIP

To devise a flight plan that carries you to the planets and moons of other solar systems, you must first travel to the system's mother star. For example, to visit the planets of the star Rigel, either fly your ship to Rigel or use the Stars command from the Location menu to transport yourself there. When you arrive, all of Rigel's planets will be available through the Location menu as well as through the Destination button of the Autopilot dialog box.

Constructing Real-Time Flight Plans

Although the autopilot and the flight computer generally take control of the time scale as they carry out your instructions, it's possible to assemble flight plans that let you make real-time journeys.

The key to creating real-time flight plans is making good use of both the Thrust and Coast actions of the autopilot. Combine these with the Orient and Turnover actions, and perhaps occasionally use a prograde orientation, and you can develop interesting flight plans that will unfold in stately real time.

You could, for example, have the autopilot orient your ship toward a distant star, apply thrust for three days, and then coast for 95 years. Then you could initiate a turnover, followed by a retroburn, followed by more coasting. Along the way, you could move your ship to a prograde orientation and inject a little thrust into your flight plan, in an attempt to make up for stellar movement. Of course, you could do much the same with a planet or moon as your destination and accomplish your task within hours or days instead of decades!





EXPLORING WITH THE CAMERA AND THE VIDEO RECORDER

Late one night, I had turned off all the lamps in my office, and the room was lit only by my computer monitor. That light came from the glowing beauty of the Milky Way and the mysterious majesty of Saturn as I piloted the All Terrain Lander around one of the planet's rings.

What had begun as a simple joyride was turning into a more mystical journey as I dropped my craft lower and lower toward the disk of rings until they began to become individual trails. As I was drawn deeper into this encounter, the thought came to me that you and I, as Space Simulator pilots, will see and experience travels that will be difficult to describe to the uninitiated, to those who haven't yet journeyed to the other side.



How do you describe the feeling of flying across the rings of Saturn as if you were plucking the strings of a celestial harp? How do you explain flying near a planet so huge and so colorful that it makes you dizzy with wonder every time you take in the sight? How do you convey your joyful surprise as a Saturnian moon comes rolling by, perhaps not noticing that you are visiting in its neighborhood? Ultimately, you might just have to sigh and say with resignation, "I wish you had been there."

But for those of you who want to communicate to others what you've found in space, Space Simulator provides both a camera and a video recorder to help you chronicle your travels. In fact, many of the illustrations in this book are space photographs I took during various adventures within Space Simulator.

ASTRONOMICALLY SPEAKING
Saturn and the Art of the Party

"Seat thyself sultanically among the moons of Saturn."

—Herman Melville, *Moby Dick*

Saturn, the sixth planet out from the Sun and the second largest planet in our solar system, has a rich mythology attached to its name. With great feasts, the Romans celebrated Saturn as the ancient god of agriculture. Ops, the goddess of plenty, was his consort, and he was the father of a family of gods, including Jupiter, whose name was given to the largest planet; Neptune, the god of the sea; and Juno, the goddess of marriage.

The pioneering astronomer Galileo was the first to see the rings of Saturn, in 1610. (His early telescope was not powerful enough to clearly identify them as rings, however; they appeared to be "handles" on either side of the planet.) The rings consist of billions of pieces of ice and debris ranging in size from dust to large rocks. Although the rings are only several meters thick in areas, they stretch outward for tens of thousands of miles. It seems fitting that the ringed beauty Saturn is named for the god whose name is also used for the very definition of unrestrained partying—Saturnalia.





TECH TIP

As a shortcut, press the Print Scrn key to open the Camera dialog box.

Using the Camera

To open the Camera dialog box, choose the Camera command from the Options menu. This simple dialog box is all you need to take photographs wherever you are in Space Simulator.



Before Space Simulator can take a photograph, it needs two pieces of information: the filename you want to assign to the image, and the type of file (.BMP or .PCX) you plan to use for storing the image.

To assign a filename, type it (using as many as eight characters) in the Image File Name box. If you don't specify a name, Space Simulator uses the default name SPACE. (When you take more than one photograph, be sure that you're not using the default filename. If you use the same name for a second photograph, the second image replaces the first.) When you take a series of photographs, you might find it useful to name them sequentially—for example, SATURN1, SATURN2, SATURN3, and so on.

You can save your space photographs as either .BMP files or .PCX files, depending on what your paint, or viewing, program can handle. Most paint programs can open both types of files. Generally, .PCX files take up less space on your hard drive, but if you want to use the image as a "wallpaper" background in Microsoft Windows, you should save it as a .BMP file (the default). To change this setting in the Camera dialog box, select the .PCX option button.

The camera automatically saves the photo in your Space Simulator directory. If you want to store your space photos elsewhere, however, you can enter the new pathname in the Directory box.

After you've told Space Simulator what it needs to know, you're ready to take the photograph. Choosing the OK button in the Camera dialog box is like snapping the shutter button on your camera. Depending on the speed of your computer and the complexity of the scene you are photographing, you might notice a slight delay as Space Simulator stores the information.

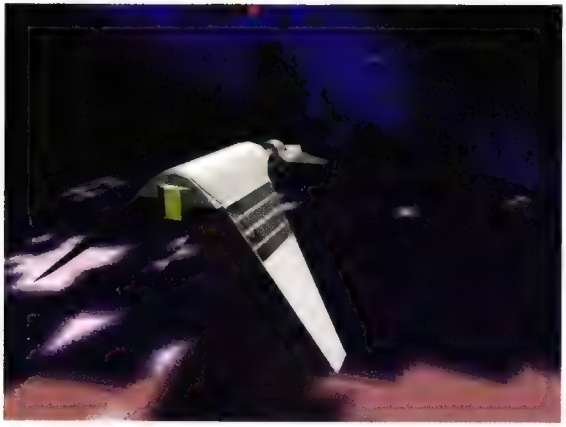
If you change your mind and decide not to use the camera, choose Cancel to close the Camera dialog box without saving any information or taking a photograph.

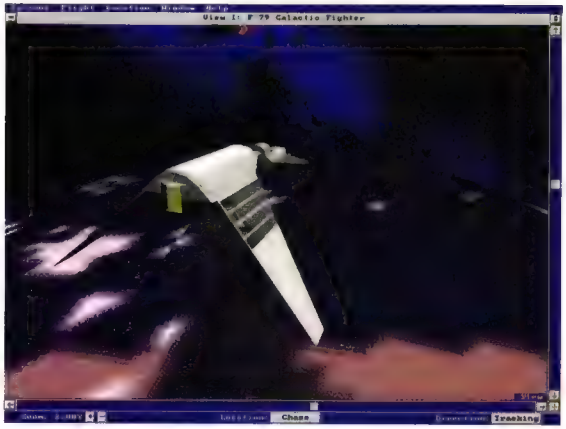
Taking Great Space Photos

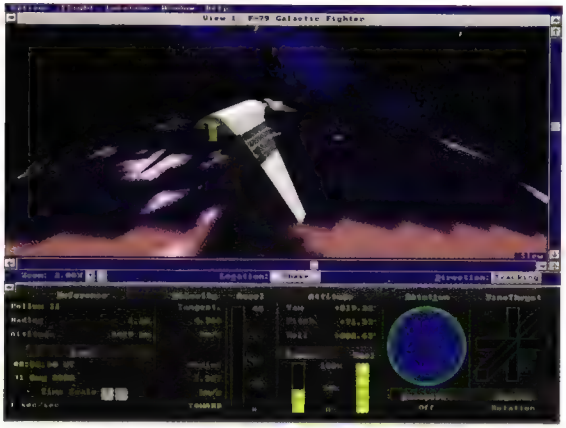
The most important secret to taking great space photos is simply to go out and do some great space exploration. Whenever you find something you want to save, just open the Camera dialog box and take a photograph—the camera is always ready.

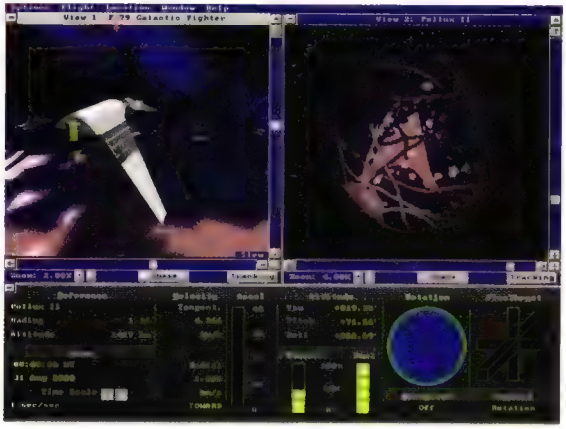
One way to get a feel for what makes a dramatic space photograph is to open virtually any of the situations that come with Space Simulator and take a careful look at those scenes. Then go back through the situations you have created and see how you like those images. Basically, the same sense of drama, scale, location, and experience that goes into making a fascinating situation is what you're after in creating a fine space photograph. The most important ingredient, though, is your own imagination.

You'll need to set up your photograph before opening the Camera dialog box—remember that as soon as you choose OK, the photograph is snapped. So you must make decisions ahead of time about the desirable framing, lighting, perspective, and so on. Let's briefly review a few of the elements you might consider.









Framing

There is no "right" or "wrong" decision about framing; it depends on what kind of photo you want to take. For example, I usually switch to Full Screen view, which hides the instrument panel and the view tools and gives the whole screen over to the image. But if you want to record a reminder of your location—perhaps a low orbit over a previously unvisited planet—you can leave the instrument panel on the screen so that the reference display and other instrument panel information become part of your photograph.



Adjusting the time scale lets you view the Mars Orbiter in good light.

Lighting

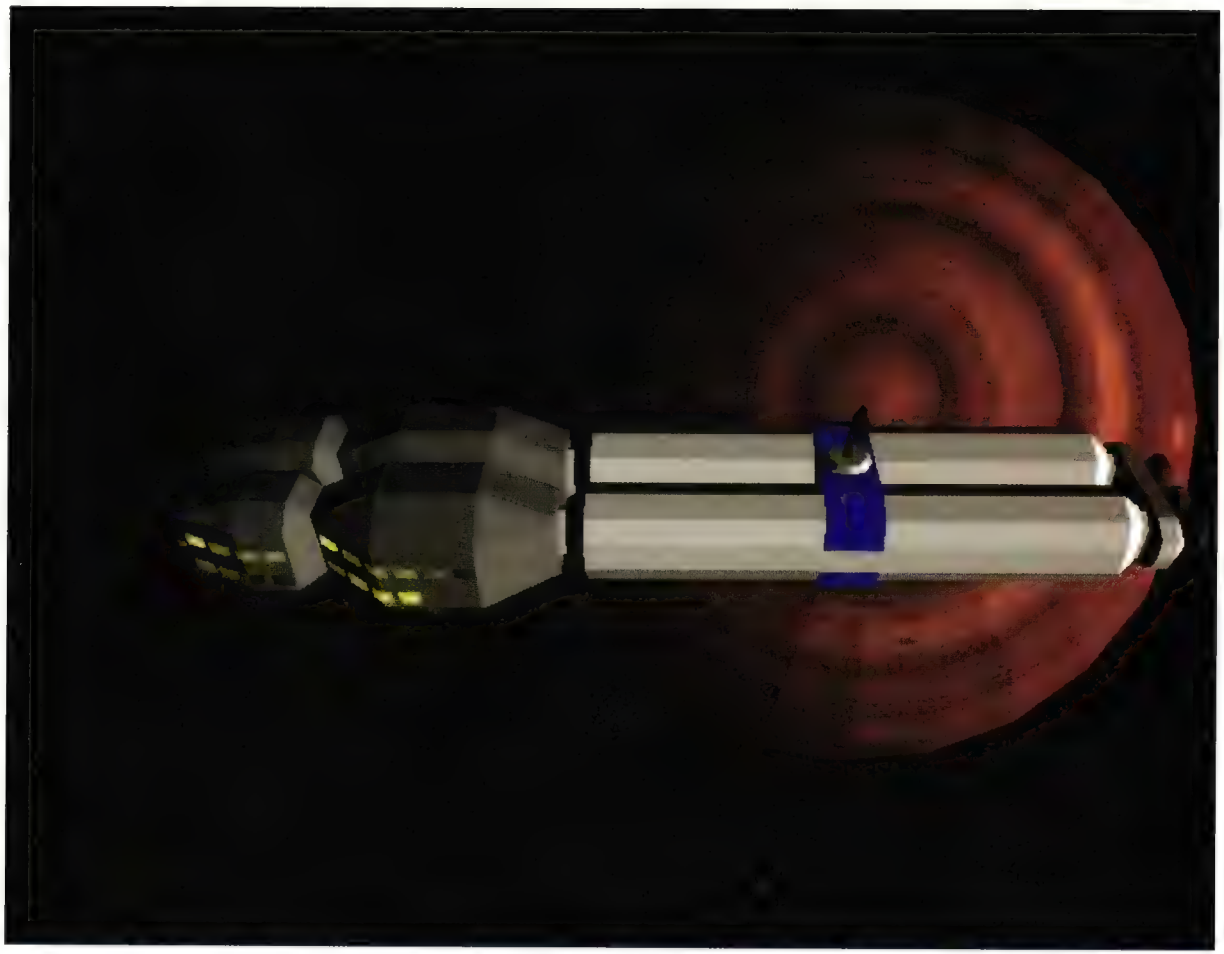
You can adjust lighting by using the time scale. Before you do this, however, it's a good idea to first save the situation so that you can easily recover if you make the image worse as you change the time scale. (For more information, see "Changing Time and Light," in Chapter 3.)

When you adjust the time scale, you'll see the lighting change on your screen, reflecting the actual movement of celestial objects in relation to their home star. As the lighting improves, be ready to press the Pause key or the F2 key to stop or slow the passage of time. While you are accelerating time to speed an object's rotation around its home star or any other object, it might go completely out of view during its dark phase, but it should come back shining as it works its way back into the sunlight.



TECH TIP

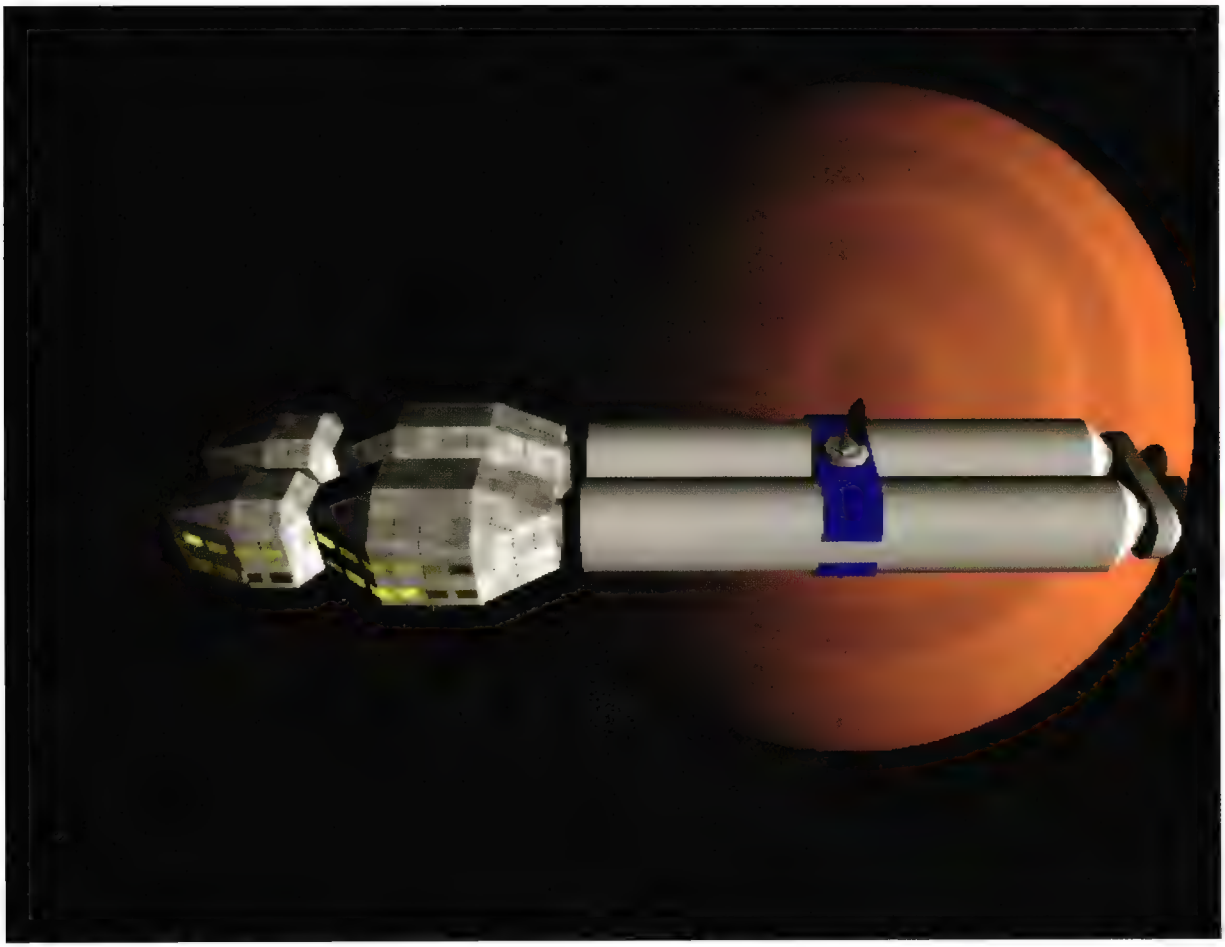
Before you speed up the time scale, be sure to press F5 to cut all thrust so that you don't blast away from your object of interest. You might also want to switch to slew control.



Rendering

As you learned in Chapter 6, you'll dramatically enhance the appearance of any Space Simulator object by displaying it with dithered and smooth shading. If for any reason you've turned off those features, choose the Preferences command from the Options menu, select Rendering, and then set your shading preferences for Dithered and Smooth in the Rendering Preferences dialog box.

For more attractive, realistic photos, you should also be sure that the Detail option in the Rendering Preferences dialog box is set for Complex.

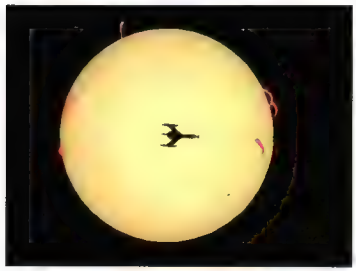


Chase Craft Perspective

When you're watching your spacecraft with Chase view, be sure that your chase craft perspective is set for absolute rather than relative. Absolute chase craft perspective makes it much easier to maneuver your spacecraft into great photo locations. The relative perspective is handy for keeping you aligned with the reference object during long passages, but I find it less interesting and more difficult to use when setting up photos. (For more information, see "Changing Chase Craft Perspective," in Chapter 4.)

"The virtue of the camera is not the power it has to transform the photographer into an artist, but the impulse it gives him to keep on looking."

—Brooks Atkinson, *Once Around the Sun*





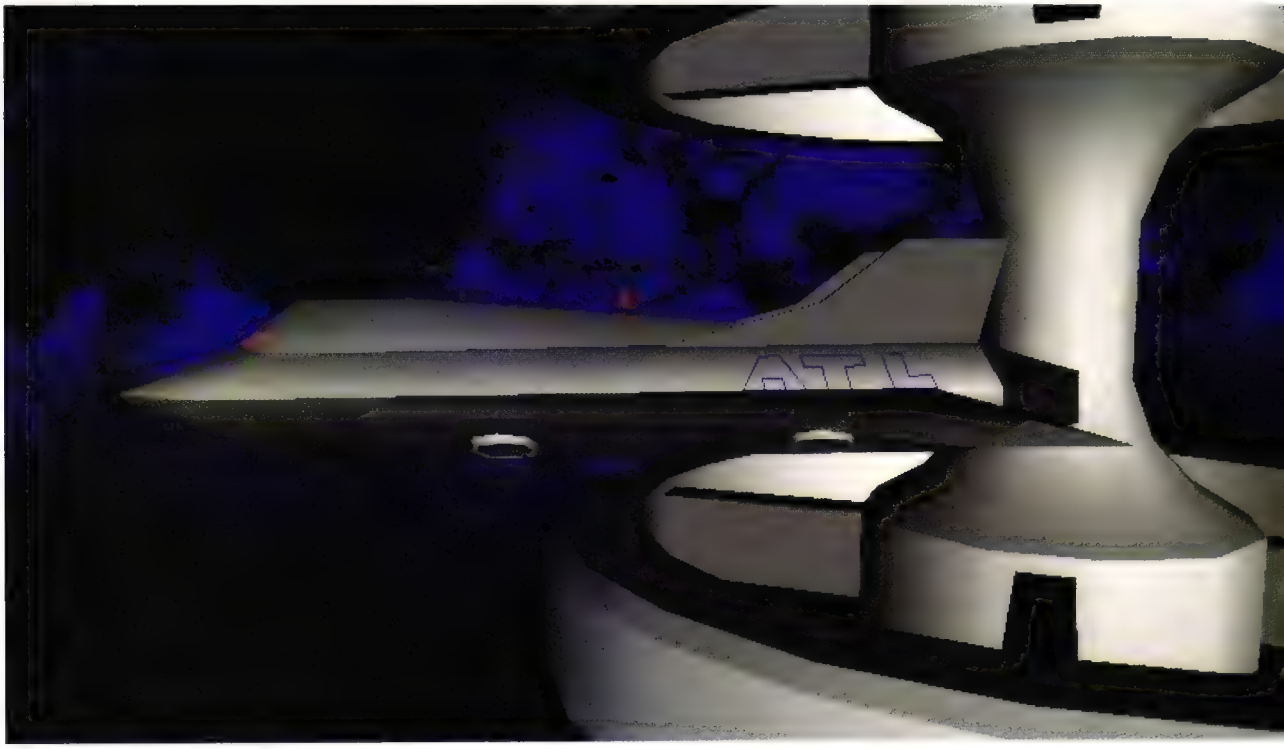
Chase Craft Distance

You can change the feel of your space photographs by adjusting the chase craft distance. For example, if you are photographing your spacecraft against the backdrop of a huge star, a planet, or even an asteroid, increasing the chase craft distance makes your ship appear much smaller, and hence the background object appear larger. This sense of proportion provides a more realistic sense of what it is like to be among the planets.

Alternatively, if the focus of the photograph is your spacecraft or the manned maneuvering unit, you might want to decrease the chase craft distance (making your ship seem larger). Be creative with the chase craft distance—it can have a marked effect on what your photograph is saying.

Pitch, Yaw, and Roll

You can significantly increase the "heroism quotient" of your photographs by strategically applying pitch, yaw, and roll. I rarely photograph my spacecraft in a nice, neat, horizontal position; my ship is always angling up, diving down, turning one way or the other, and nearly always with a nice roll. (Of course, within the vacuum of space, there would be no real reason for my ship to be rolling through a corner, but it sure looks sweet. Venturing into space isn't likely to detract too much from the deeply embedded need some humans have to look fast and rakish.)


ATL


ATL

Displaying Your Photos in Microsoft Windows

Space Simulator doesn't have its own internal art program in which you can view your photographs after you take them. But you can open up Space Simulator photographs, whether you've saved them as .BMP files or .PCX files, in any number of graphics programs. One of these, called Paintbrush, comes with Microsoft Windows.

Opening Your Photos in Windows Paintbrush

1. Exit Space Simulator by choosing the Exit command from the Options menu. (Yes, you have to go back to the real world to see your space photos.)
2. Start Microsoft Windows, and open the Program Manager.
3. Find the Paintbrush icon (usually located in the Accessories program group), and double-click it to open the Paintbrush program.
4. Choose the Open command from Paintbrush's File menu to display the Open dialog box.
5. In the Directories list, select the directory in which your space photographs are stored. By default, any photos that you saved as .BMP files now appear in the File Name box. If you saved a photo as a .PCX file, click the down arrow beside the List Files Of Type box, and select PCX Files from the list to display the names of .PCX files in the File Name box.
6. In the File Name box, select the name of the file you want to open, and then choose OK. Paintbrush displays the space photograph, along with a palette of tools you can use to crop or modify the photo.

Creating Wallpaper with Space Photos

1. Exit Space Simulator.
2. Start Microsoft Windows, and open the File Manager. Open your Space Simulator directory by double-clicking it.
3. Select the .BMP file containing the photo you want to use as wallpaper. To make the image available to Windows, hold down the Ctrl key and drag the highlighted file to your Windows directory.
4. Move to the Program Manager. Find the Control Panel icon (usually located in the Main program group), and double-click it to open the Control Panel.

5. From the Control Panel, double-click the Desktop icon to open the Desktop dialog box. In the Wallpaper section of the dialog box, select either the Center option button or the Tile option button. To display a single image, select Center; to duplicate the image so that copies of it cover the entire screen, select Tile.
6. Click the down arrow beside the list box in the Wallpaper section. When the list drops down, select the name of your space photo, and then choose OK.

Now, whenever you run Windows, this photo will be the image you see as the backdrop for your more terrestrial work.

Making Movies with the Video Recorder

If you have ever even entertained the notion of making a movie, this feature is for you! If you've ever sat transfixed before a big screen, watching *Star Wars*, *Star Trek*, or *2001: A Space Odyssey*, here is your chance to make your very own movies about space.

Beware, though—when it comes to storage space, Space Simulator can be the Godzilla of your hard drive, gobbling up megabytes of space faster than the great green lizard used to swallow cars in downtown Tokyo. You needn't be frightened by this warning, however; simply be forewarned that using the video recorder can take up a lot of room on your hard drive. Fortunately, as you'll see, Space Simulator provides an easy way of deleting old videos.

Controlling the Video Recorder

To prepare for recording a video, choose the Video Recorder command from the Options menu. In the Video Recorder dialog box (shown on the next page), type a filename for the video and, optionally, a description of what you'll be recording. If you want to store your video in a directory other than the default directory, type the name in the Directory box.



In the Region To Record section of the dialog box, select the Active Window option button if you'd like to record only what's displayed in the active window. To record in Full Screen view (hiding the instrument panel and the view tools), select the Full Screen View option button; to record everything on the screen, select Entire Screen. (Entire Screen is the only one of the three options that lets you change your window arrangement during recording.)

To start recording right away, choose the Record button. If you'd rather save all the video information and return to the main screen to get your video set up before you start to record, choose the Close button instead. Then, when you're finally ready to record, just press the R key to begin making the video.

As you record, the frame counter in the upper left corner of your screen shows the number of frames recorded as well as how much storage space the video is taking up on your hard drive. Watch this display to monitor the growing size of the file in relation to your available disk space. (Remember that 1,024 kilobytes equal 1 megabyte of hard drive space.) To reduce the size of a video file, you can record

using the Active Window option rather than Full Screen View or Entire Screen. In general, the faster your computer, the more frames are recorded per second, and the larger your files will be.

When you're ready to stop recording, either press the backslash (\ ) key or open the Video Recorder dialog box and choose the Stop button. (The dialog box does not become part of your video; opening any menu immediately pauses the simulation and the current recording.)

After you stop recording, four pieces of information appear in the Description section of the Video Recorder dialog box: the screen resolution, the number of screen frames recorded, the total size of the video image file, and the area of the screen that was recorded. You can add your own description of the video beneath this information, or you can backspace over the information to erase it, clearing the Description box for your own use.

Once you've recorded a video, you'll surely want to play it back. To play a video you recorded earlier, reopen the Video Recorder dialog box and select the name of the video. If you want it to play again and again until you choose to stop it, turn on the Looping Playback check box. Then just choose the Play button. Alternatively, you can choose the Close button and then press the P key when you're ready to view the video. To stop a video before it finishes playing (or to stop a continuously looping video), press the backslash key.



TECH TIP

You must use the same screen resolution for both recording and playing back a video. For instance, if you're running Space Simulator with a resolution of 320 by 400 pixels, you can't play back a video you recorded with a resolution of 800 by 600.

Whether you're recording or playing back your video, you can temporarily halt the process by choosing the Pause button or—handier still—pressing the U key. When you're ready to resume the action, simply choose the button or press U again. As you'll see in the next section, the ability to pause during recording gives you an exciting range of creative options for your videos.

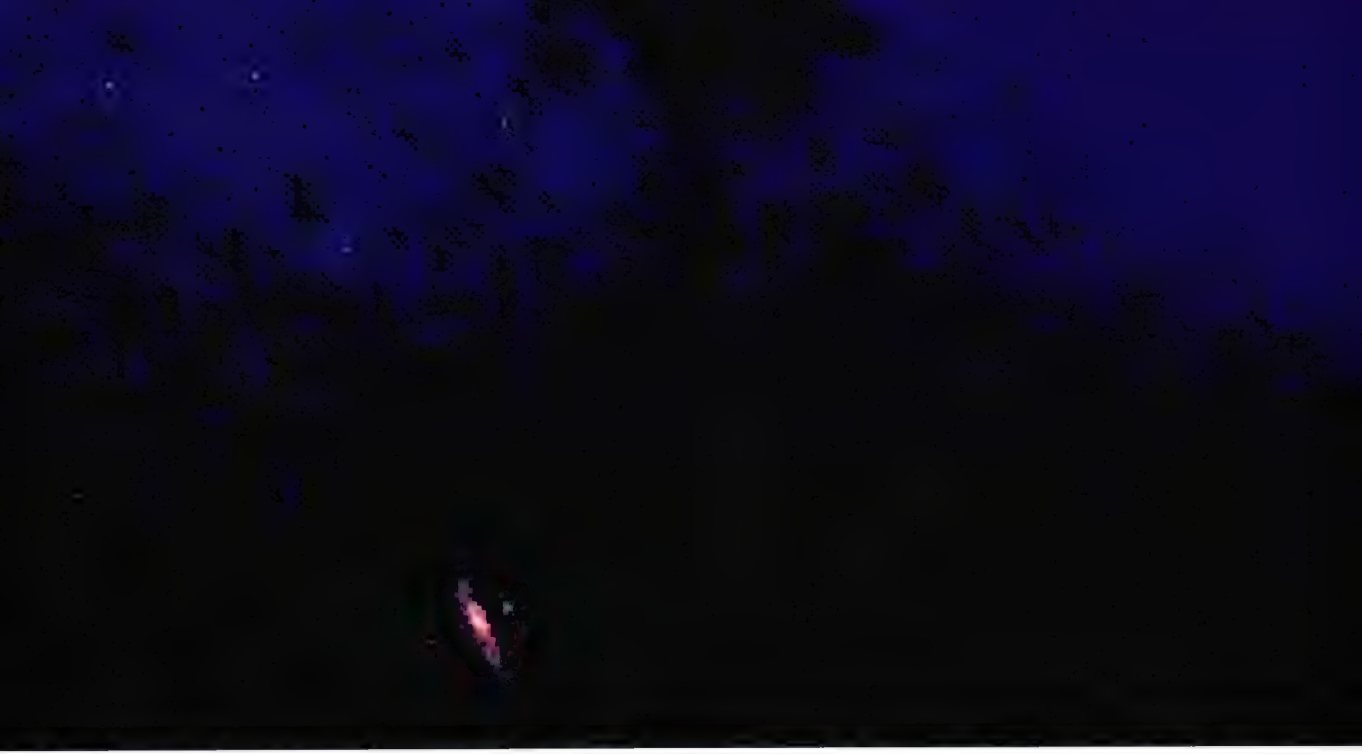
You'll probably want to delete old videos fairly often because their files can consume so much space. It's easy to do: Open the Video Recorder dialog box, and select the video's name from the list. Check the Description box to be sure that you're deleting the right file, and then choose the Delete button. Space Simulator displays a second dialog box asking you to confirm your intentions; choose OK to delete the file or Cancel to stop the deletion. Then choose the Close button.



As you work with the video recorder, be sure to learn the shortcut keys right away; using them is almost always simpler and faster than returning to the Video Recorder dialog box. Once you have set up the file so that it's ready to save your recording, you can close the dialog box and control the video recorder with the shortcut keys. Because they're so handy, here's a quick reminder of what they do:

- The R key starts recording the video.
- The backslash key stops recording or stops a playback.
- The P key begins playing back the currently selected video.
- The U key pauses or resumes recording or a playback.

When you use these easy shortcut keys, Space Simulator's video recorder can seem like a real video camera whose controls are accessed simply by pressing a few buttons.



Using Pause to Edit Your Movies

The real fun with the video recorder begins when you use the U key (or the Pause button) to splice together different scenes in your video, as though you were editing a movie. Pressing the U key lets you stop recording, without closing the file. This means, for example, that you can begin recording on Earth, press U to pause, open a new situation that is based on the Moon, and then press U again to resume recording. If you press this key again, the recorder stops so that you can open yet another situation, for yet another scene in your movie.

When you are splicing together various situations in a single video, the only requirements are that each situation must appear at the same resolution—640 by 400 pixels, for instance—and that the view windows in each situation must be configured the same way. For example, if your first scene takes place in Full Screen view, you can't continue your recording with a second situation that displays the instrument panel.

This ability to go from situation to situation, using the U key to pause between takes and set up your scenes before resuming the same recording, is extremely powerful. Let's hope that it unleashes all kinds of creativity as people experiment with Space Simulator's video recorder!



TECH TIP

Remember the time scale as you make videos. You can, for instance, press F1 to accelerate the passage of time before you begin to record—or even while recording. Speeding up the action on screen can provide interesting effects, and it's also useful for scenes that might otherwise unfold too slowly to justify the space they consume on your hard drive.



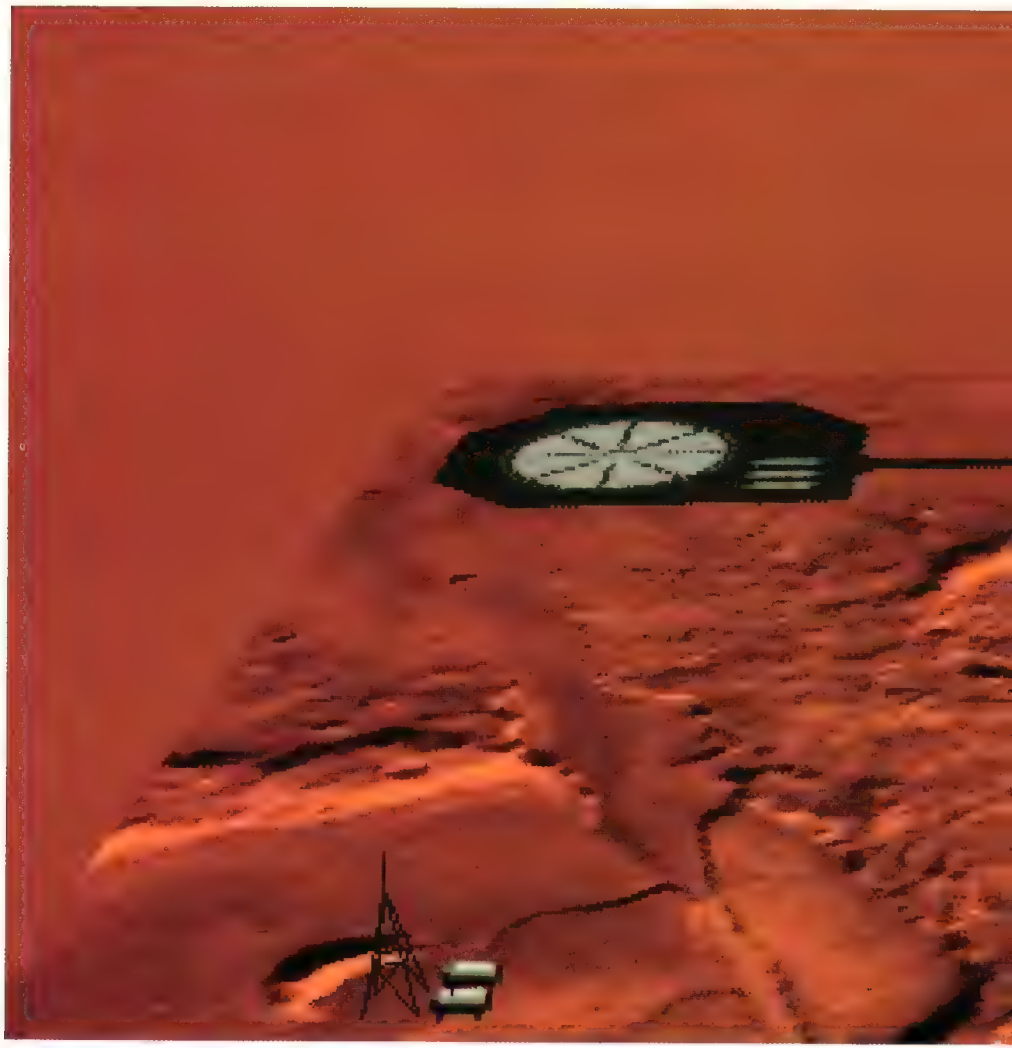


MISSION: The Mars Movie

Someday, magnificent movies will be made on Mars. For Hollywood-type, Earth-based cinematographers, the wait for such a location shoot could stretch out for many decades. But with Space Simulator, you can begin that great movie right now. Your movie can be straightforward and educational, like a *National Geographic* special, or it can be a techno-thriller, with the mysterious MMU darting about between buildings and flowing through one scene after another. Let your imagination be your guide, and let Space Simulator be your video camera.

Preparing for the Mars Movie Shoot

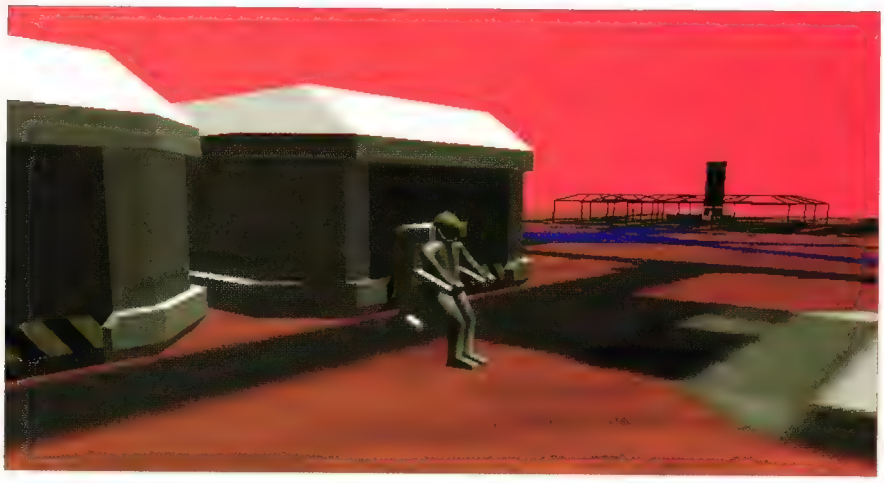
1. Choose the Open Situation command from the Options menu. In the dialog box, select MMUXPLOR and choose OK. You're now flying the MMU toward Mars Base Marineris, the location of your epic movie.
2. Press the W key to switch to a full-screen display—you can say you're making a movie for the "big screen."



3. Fly yourself nearer to Mars Base Marineris, and position the MMU to provide a nice aerial view. This view will be the opening scene of the movie.
4. Choose the Save Situation command from the Options menu, and save this situation with the name SCENE1. You'll be able to open this situation later to begin your video recording.
5. Position the MMU directly above Landing Pad 1. Apply downward thrust for a landing, in preparation for the second scene.



6. Save this new situation, naming it SCENE2. Because you have already applied thrust, this scene will capture the MMU as it descends onto the landing pad.
7. Fly the MMU over to the large hangars, and position the MMU so that it is approaching them with modest velocity. Save this as another situation, SCENE3. Make the scene dramatic; I like to position the MMU so that it is flying out from between the two large hangars or doing something else interesting.



8. Fly the MMU over to the colony's housing facility, a structure that looks like a great blue robot. Apply thrust so that the MMU is flying across the front of the structure. Save this situation, and name it SCENE4.
9. Switch to Cockpit view, and position the MMU for a quick run between the greenhouses. Apply thrust to send the MMU on its way, and then save this situation as SCENE5. This scene will provide the "Steadicam" action.
10. Now position your MMU for a slow ascent of the water and oxygen drilling tower. You'll want to switch back to Chase view so that you can see your MMU. Apply thrust to have the MMU begin ascending the drilling tower, and then save this situation as SCENE6.
11. After reaching the top of the tower, slowly rotate the MMU so that you can see the entire Mars base, with the MMU in the foreground. Once you've rehearsed this and have positioned the MMU properly with the right amount of rotation, save this situation as SCENE7—the closing scene.



ASTRONOMICALLY SPEAKING
Mars, the God of War

The fourth planet from the Sun, Mars was named for the Roman god of war. Perhaps it is the red color of the planet, which the ancients associated with blood, that has made it such a fascinating object to Earth dwellers.

This image of Mars has persisted even through most of our current century, with writers such as Edgar Rice Burroughs and others penning science fiction epics about heroic earthlings fighting Martian monsters. When Orson Welles staged a radioplay version of the H. G. Wells story "War of the Worlds" in 1938, panic swept through the United States as millions of listeners were convinced that the country was being attacked by invaders from the red planet.

Nevertheless, despite the unfriendly way we've historically viewed the planet Mars, it appears to be our best hope for long-term efforts to create a habitable, Earth-like world.



Recording Your Mars Movie

1. Choose the Open Situation command from the Options menu. In the dialog box, select SCENE1—the first scene of the movie—and choose OK.
2. Choose the Video Recorder command from the Options menu. In the Video Recorder dialog box, type *MARSMOVY* in the File Name box. Then, in the Description box, type a brief description of what you'll be doing.
3. In the Region To Record section, select Entire Screen. All the scenes in your movie will use the entire screen. Turn on the Looping Playback check box, and then be sure to choose the Close button rather than Record—the Close button sets up the file and closes the dialog box without starting to record immediately. This allows you to begin the video precisely when and where you choose.
4. The video recorder is ready to go. Watch your situation unfold a few times (using the Reset Situation command from the Options menu) until you know exactly when you want to begin filming. You can consider this a "rehearsal."

5. Press the R key to begin recording. While the video recorder is taping, keep an eye on the frame counter in the upper left corner of the screen and monitor how many kilobytes of storage space the video is consuming. Your moviemaking will be limited by the amount of hard drive space you can allocate.
6. When you have filmed as much of SCENE1 as you need, press the U key to pause the video recording. In Hollywood parlance, you could shout: "That's a take!"
7. Using the Open Situation command, open SCENE2. After a couple of rehearsals, press the U key to resume recording and begin shooting your second scene. The frame counter reappears in the upper left corner of the screen, letting you know that the video recorder is on again. Don't worry—this readout won't be part of the video.
8. Press the U key to pause the recording after you have shot the footage you want from SCENE2. That's another take!
9. Open SCENE3, and continue with the process of rehearsing the scene, resuming the video recording, pausing, and opening the next situation until you have worked your way through SCENE7.
10. Press the backslash key to stop the recording when you come to the end of your final scene. Break out the popcorn, and get ready for the big world premiere!
11. Choose the Video Recorder command from the Options menu, and choose the Play button in the dialog box—or simply press the P key, without choosing the command. The movie begins. Because you turned on the Looping Playback feature, the movie will play over and over. When you're ready to end the playback, press the backslash key.

If you'd rather have the movie play only once in any future showings, you can reopen the Video Recorder dialog box, select the name of the video, and turn off the Looping Playback feature.

If you use SMARTDrive or another disk caching system, your video recording will play back more smoothly the second time through, as long as its total filesize doesn't exceed the capacity of your disk caching system. During the second play, the computer accesses the information from memory rather than from your hard disk. Whether you have disk caching or not, you'll have an enjoyable time watching your movies.



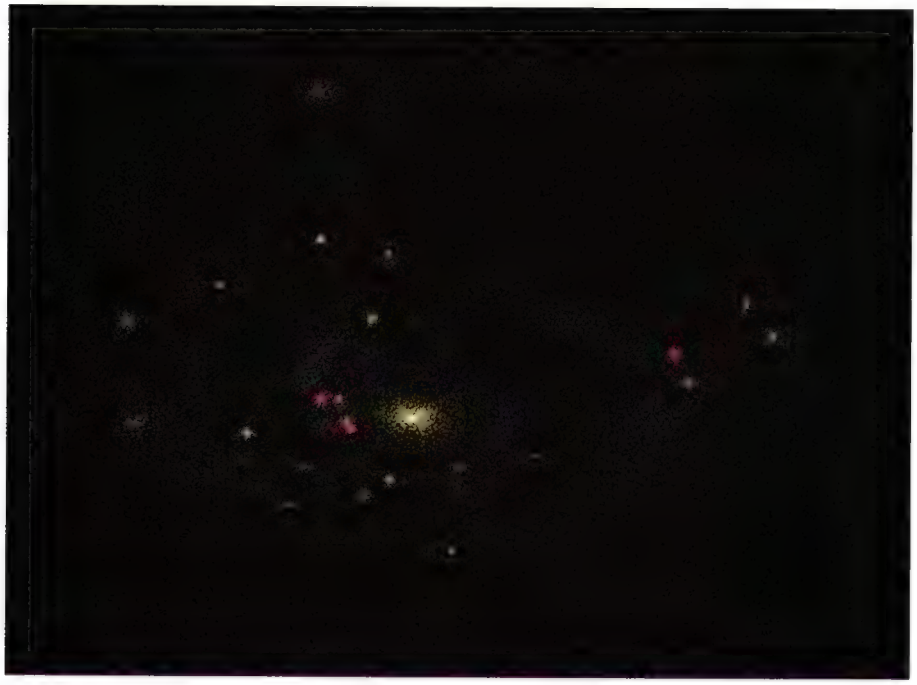
TECH TIP

For precision editing, you can do a practice recording for every scene. Open the situation, begin recording, and note the exact frame number when you find the best spot to pause the recording. Then, when you reshoot the final movie, you can watch the frame counter and pause at the correct frame number for each scene.

Don't Forget the Soundtrack!

As you use Space Simulator's video recorder to create your own movies, don't forget the power of music. All great movies have memorable soundtracks. You've got the video—now add a soundtrack, and you've got the beginnings of a wonderful multimedia creation. Adding a soundtrack is easy: Just pull out your favorite tapes or CDs and turn up the volume!

Of all the audiovisual combinations I've experienced so far, the most moving was one created by Rich Choi, a program manager in Microsoft's games group, in which we slowly leave the galaxy as the finale to Gustav Mahler's *Resurrection Symphony* plays. At the end of this piece, the symphonically backed chorus sings about death and moving on to another realm. As the voices are raised in celebration, the spacecraft recedes far enough from the Milky Way to let us see the galaxy as a slowly rotating disk. It is as if, carried on wings of song, we are departing the entire galaxy and heading on to somewhere new.





FLYING LIKE A STARSHIP MASTER

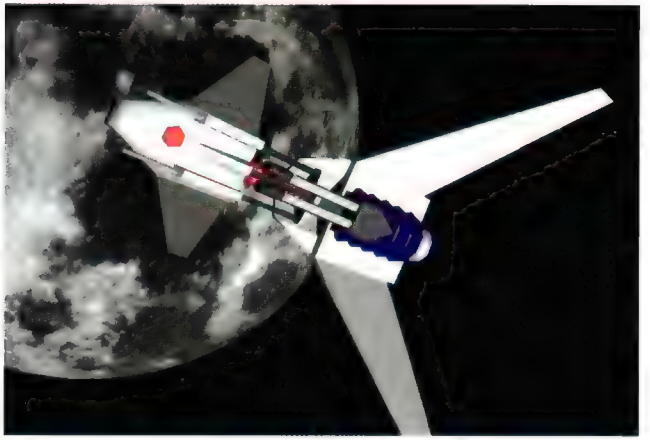
As I tumble into the realm of space once again, I immerse myself in the wonders of the galaxy. I travel across interstellar voids and swing into planetary systems, controlling my ship as casually as I would drive my car along a back road with no traffic.

It's always fun to really get out into space. As pressing the keyboard controls and moving the joystick emerge as second nature, and as the menu commands begin to seem like additional displays in the cockpit of your spacecraft, you become one with Space Simulator—you advance to being a starship master, effortlessly diving into the experience so completely that you seem to leave Earth very far behind.



During such spaceflights, even my CD player becomes part of my ship. (Surely all spacecraft of the future will be nicely wired for sound!) My office is transformed into an extension of the ship's command bridge—extra computers, books, papers, and all. Sometimes, while heading for a distant object, I get up from the controls, walk down the corridor, and head for the cafeteria as if I'm strolling to the ship's commissary. Walking across Microsoft's campus, with its fountains and gardens and trees, feels like walking across the ship's atrium, placed there to keep us space-farers from feeling too disoriented as we cross the great void of the unknown.

Then it's back to the control room, my dark office the ship's bridge, where I sit back down to take control. Whether I'm chasing the moons of Jupiter against the beauty of the Milky Way or making the passage to Polaris to trek among its planets, there's great exhilaration in being so in tune with my ship that I feel like a keyboard artist, playing a song that is the journey of my ship.



BEHIND THE SCENES
Voyaging with a Starship Master

Watching the ease with which Jon Solon journeys through space and controls his spacecraft inspired the idea of a "starship master." On one voyage, Space Simulator's program manager took off from Cape Canaveral in the F-79, using the joystick to control pitch, yaw, and roll, and pressing F6 and F7 to adjust thrust. As the F-79 reached the upper atmosphere, he pressed the G key to raise the landing gear and reposition the wings, F8 to provide full thrust, and L to find the Moon. He tapped the F1 key a few times to speed up the time scale. Then he slowed as he closed in on the Moon and pressed the Ctrl key as he pulled to the right on the joystick to bank around the Moon.

Heading back toward Earth, he set Cape Canaveral as his reference object. He then pressed H to turn on the head-up display and F1 to speed up time. "I guess it's North America we're looking for," he joked as we neared Earth. As we closed more, someone spotted the Yucatan Peninsula, and then Florida rolled into view. With amazing bravado, Jon turned off the head-up display over Florida and made a visual landing at the Cape (keeping an eye on the attitude display readouts). He applied reverse thrust after landing and brought the F-79 to a stop on the runway, a perfect ending to his quick once-around the Moon. Through it all, he had looked at his controls only as much as a jet pilot might have.



Fun with Atmospheric Entries

One of the greatest challenges in space piloting comes when you leave a massive starship such as the Zander Freighter in orbit, deploy the All Terrain Lander, and head toward a planet for an atmospheric entry.

Whether you are flying the ATL, the space shuttle, or the F-79 Galactic Fighter, an atmospheric entry is a daring maneuver that requires skill and attention to details. One key detail is how fast you're traveling when you first hit the planet's atmosphere. If your skill level is set for Practice, you can enter the atmosphere at any velocity. But when you set the skill level for Intermediate or Advanced, you'll encounter a "temperature crash" if your velocity exceeds about 50 kilometers per second when you hit the upper atmosphere.

Determining Where the Upper Atmosphere Begins

When you're approaching a new planet, how can you tell just where the upper atmosphere (and its heat-causing friction) will kick into gear? One method (not advised for the squeamish) is to simply head toward the planet's surface, with your skill level set for Intermediate or Advanced. Be sure that the instrument panel's reference display indicates radius and altitude. Note your altitude when the Temperature Crash message box appears on screen, and then try again.

TECH TIP

You can adjust your skill level setting in the Skill Level Preferences dialog box. For atmospheric entries, the parameters of the Intermediate and the Advanced skill levels are the same.



ASTRONOMICAL NOTE

Most moons aren't massive enough to gravitationally capture an atmosphere. And the atmosphere of a star is made up of unimaginably hot gases (measured in millions of degrees Fahrenheit), which would melt you and your ship long before your arrival.

A second method is a bit more scientific. Choose the Planets command from the Location menu, and select your destination planet—let's say you're heading for Venus. In the Description section of the Planets dialog box, you'll find the diameter of Venus (12,104 kilometers). Divide the diameter in half to find the radius (6,052 kilometers), and then multiply the radius by 1 percent. The result (60.5 kilometers) is the altitude above the surface of Venus at which your ship will first encounter atmospheric effects. Space Simulator uses 1 percent of a planet's radius as the beginning point for that planet's atmosphere.

BEHIND THE SCENES
Creating an Atmosphere

One of the many intense challenges of programming Space Simulator was developing a robust algorithm for modeling atmospheric effects—not only for Earth but also for all the other planets the product contains. The developers first determined that atmospheric effects would kick in at an altitude equal to 1 percent of the planet's radius. But what would happen then? And how could they show the changing atmospheric pressure as you flew nearer the surface?

"Before you get within 1 percent of the radius, Space Simulator pretends that you're in a perfect vacuum," said Charles Guy. "Once you enter the atmosphere, a continuous function makes the atmosphere incrementally denser as you get lower. This function is based on the thermodynamics of an idealized gas in a gravity well. We used real numbers for each planet, so each planet has its own parameters. The atmosphere of Mars is different from that of Earth."

What else went into the modeling? "We took the molecular weight [of the primary atmospheric gases], multiplied that by the temperature of the planet, and added a factor for gravity," Charles explained. "Jupiter, Saturn, and Neptune each create energy themselves, something we didn't factor in. But we've gone to some trouble to make this as realistic as we can."

▲ ▲ ▲



TECH TIP

Remember that different planets have different atmospheres. For example, it takes much longer to slow down during an entry through the relatively thin atmosphere of Mars than it does in the denser atmosphere of Earth or Venus. Generally speaking, the less massive an object, the less gravity it exerts—and the less dense is its atmosphere, resulting in less friction to slow a spacecraft.

Practicing an Atmospheric Entry

Tester Roger Pettibone created Space Simulator's REENTRY situation specifically for practicing atmospheric entries. As the situation opens, you are orbiting in the F-79 about 370 kilometers above Earth's surface, located on the opposite side of Earth from the Shuttle Landing Facility at Cape Canaveral. The time scale is at its slowest setting, 0.001 second per second, to allow you plenty of time to begin your maneuvers without worrying about your spacecraft orbiting out of position.

In this classic scenario, a deorbit burn (which we'll discuss further in a later section, "Using Retroburns to Alter Orbits") is applied 180 degrees from the landing facility, giving you a chance to "surf through the atmosphere" en route to your landing site. After a few false starts in positioning, Roger created the situation by using the Location menu to place his spacecraft at Cape Canaveral. He then opened the Set Location dialog box to obtain his current latitude and longitude (28 degrees, 30 minutes north latitude and 80 degrees, 47 minutes west longitude). Using the Set Location dialog box, Roger next placed his spacecraft at an altitude of 415



kilometers and at a position of 28 degrees, 30 minutes *south* latitude and 99 degrees, 13 minutes east longitude (180 degrees away from Cape Canaveral's longitude). And then, of course, he saved this situation so that he wouldn't have to do it all over again! By the time he got the ship's velocity right and completed the final save for the situation, he had moved from his point of origin. But you'll still have more than 13,000 kilometers to travel through as you pilot your ship home. Have fun!

Landing at Cape Canaveral

1. Choose the Open Situation command from the Options menu. In the dialog box, select REENTRY and choose OK. You're placed in orbit, halfway around the globe from Cape Canaveral.
2. Choose the Spacecraft command from the Flight menu. In the dialog box, select All Terrain Lander and choose OK. Flying the ATL will let you try a landing that uses pods instead of wheels.
3. Choose the Autopilot command from the Flight menu. In the dialog box, select the Retrograde action, check to be sure that Earth is the destination, and choose the Execute button. This action reverses the direction your ship is pointing. Applying thrust will now slow your velocity.
4. Press F8 to apply maximum thrust. Initially you won't notice much response because the situation opens with the time scale set quite low.
5. Press F1 a few times to speed up the time scale. Monitor the tangential velocity readout to ensure that velocity doesn't drop below your goal of 7.575 kilometers per second, which would cause you to fall short of your destination. As you increase the time scale setting, the thrust has more impact on your tangential velocity.
6. When tangential velocity drops to 7.575 kilometers per second, press F5 to cut all thrust. As your velocity slows, the lowest point of your orbit will drop even lower, which allows you to be skimming along close to the surface of Earth by the time you reach Cape Canaveral, near the tip of Florida.
7. Choose the Autopilot command from the Flight menu. In the dialog box, select the Prograde action and then choose the Execute button. The autopilot swings your ship back around so that you'll be moving in the right direction when you hit the atmosphere.
8. Use the rotation keys or the joystick to keep Earth in view along the bottom of your cockpit window as you continue to lose altitude from the deorbit burn. Earth should fill the bottom quarter or so of your screen. The planet is still in the dark, but you'll be able to make a daylight landing at the Cape.
9. Press F1 and F2 to adjust the passage of time to your own liking. If things get tense, especially before maneuvers, you can slow the time scale to less than 1 second per second, or you can temporarily stop completely by pressing the Pause key.
10. Turn on the head-up display after your spacecraft enters the atmosphere at an altitude of 63 kilometers. You'll know you've entered the atmosphere when your velocity readout displays ground and vertical velocity rather than tangential and radial. For the next phase of the landing, it will be important to monitor the vertical velocity readout.

11. Use the rotation keys or the joystick to adjust your pitch so that the vertical velocity readout is near 0. If you pitch up too much, you'll fly up out of the atmosphere and will need to reenter. And if you pitch down too much, you'll lose altitude too fast and won't make it to Cape Canaveral's Shuttle Landing Facility.
12. Press Alt-R. In the Select Reference Object dialog box, select Surface, select Shuttle Landing Facility, and choose OK. The HUD as well as the attitude readouts shift from Earth to the landing facility.
13. When the reference display shows that you are within about 50 kilometers of the landing facility, begin a gradual descent. By the time you are approximately 12 kilometers from the landing site, your altitude should be down to about 4 kilometers.
14. Try switching to Chase view; you might enjoy this perspective for the final landing.
15. Make good use of your yaw and pitch readouts as you zero in on the landing strip. If you don't make it the first time, try again, saving the situation frequently along the way.
16. As you near the landing strip, apply reverse thrust to cut your forward velocity, and then use the PgDn key (and the PgUp key, if you need to slow your descent) to bring the ATL down on its three landing pods. This is like a hovercraft landing.



TECH TIP

After making it this far, don't forget to lower your landing gear. Press the G key to toggle the landing gear up and down.

Using Fine Thrust to Fine-Tune Your Approach

Whether you're flying the ATL or one of the other "landable" ships such as the F-79 or the space shuttle, you can make strategic use of reverse fine thrust if it looks like you're going to overshoot your landing site. Or, if you are falling short of your target and want a bit of a boost, try applying either forward fine thrust or full thrust. As you experiment with such variations, think Save Situation so that you can begin each trial from the same location without repeating the preliminary stages.

Aerobraking and Atmospheric Skipping

As you might have discovered during your Cape Canaveral landing, if you pitch up too much, your spacecraft will be bounced back out of the atmosphere. Actually, this can be a lot of fun. You can become a planet-hopping pilot from the pages of science fiction as you skip across an atmosphere without bothering to go down for a visit. Or you can be a bit less radical and use the atmosphere for slowing your ship, a process called *aerobraking*. Just pitch the nose of your ship upward, but not so much that you'll be immediately bounced out of the atmosphere.

Orbital Mechanics for the Starship Master

Part of becoming a real starship master is being able to use terms such as *perigee* and *apogee* and commenting on the changing characteristics of your orbit as you watch your spacecraft in Map view. The concepts of perigee and apogee are at the core of much of what we know about movement in space. Virtually everything in the universe seems to be in orbit around one thing or another, and very few of these orbits are perfectly circular. In an elliptical (oval) orbit, the term *perigee* describes the point at which you are closest to the object you are orbiting, and *apogee* describes the most distant point of the orbit.



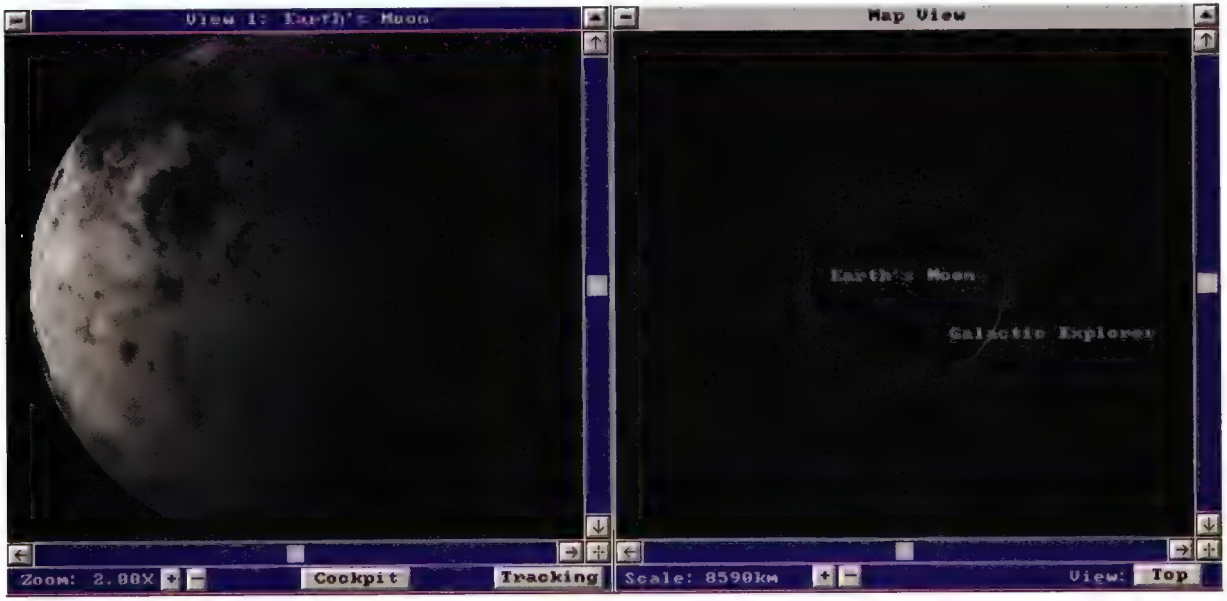
TECH TIP

You can change your vantage point in Map view by choosing the View button in the lower right corner of the Map view window.

Monitoring Orbits

Using Map view is a great way to monitor an orbit. Let's try this out:

1. Using the autopilot, place yourself in orbit around Earth's Moon.
2. Choose the Show Map View command from the Window menu, and then press the O key (the letter O, not zero) to display the Select Map Origin Object dialog box.
3. In the dialog box, select Moons from the Object Type list, select Earth's Moon, and choose OK to set the Moon as the origin of the map.



4. Choose the View Controls command from the Window menu. In the dialog box, select the Map View option button, and then turn on the Moons check box in the Show On Map list. Choose OK to close the dialog box.
5. To watch your spacecraft orbiting the Moon, as shown on the previous page, adjust the map scale (located just below the map window) by clicking on the plus sign or minus sign button.

Although your orbit will probably look nearly circular in Map view, you can discover the variations in its shape by watching the reference display's altitude or distance readout; the distance is greatest at the apogee and smallest at the perigee. With your velocity readout set for tangential and radial velocity, you can also watch your tangential speed go down as your orbiting ship climbs toward apogee and then begin to build again as the ship is gravitationally drawn back toward perigee. You can learn a lot about orbital mechanics simply by watching these readouts.

Elongating and Circularizing Orbits

A lot of space piloting comes down to either elongating or circularizing orbits. Elongating an orbit gives it a more pronounced oval shape and a more distant reach. This is accomplished by applying additional thrust at the point of perigee. This "perigee burn" provides your spacecraft with more velocity as it heads back out toward apogee, creating a more distant point of apogee.

You can make an orbit more nearly circular (and less oval) by applying thrust at the point of apogee. This additional thrust as your spacecraft heads back toward perigee extends, or raises, the perigee.

In theory, you could travel from Earth to Venus simply by elongating your ship's orbit around Earth until it intersects the orbit of Venus around the Sun. You would, however, need to time the arrival of your spacecraft to coincide with the passage of Venus through your point of apogee.

Using Retroburns to Alter Orbits

You can also adjust an orbit by using a *retroburn*. This term describes applying thrust while in a retrograde (as opposed to a prograde) orientation with the object you are orbiting. You can use the rotation keys and the yaw readout to rotate your craft by 180 degrees so that it is essentially flying backward. At that point, applying thrust from your main engines slows your orbital velocity.

A simpler method is to use the autopilot's Retrograde action. After you execute this action, any thrust applied will constitute a retroburn, slowing your orbital velocity and hence reducing your orbital height. A perigee retroburn reduces the height of your apogee and tends to make your orbit both more circular and lower. When a retroburn is used to lower your perigee to the point of landing on the surface of a planet or moon, it is sometimes called a *deorbit burn*.

Using the Observatory

Great starship pilots like to have an idea of where they are going and what they will see. Space Simulator offers a network of observatories spanning our solar system. When you choose the Observatory command from the Options menu, your spacecraft's instrument panel is replaced with the observatory's instrument panel.

As you soar through space, you can, with only a couple of keystrokes, activate a telescope on top of Hawaii's Mauna Kea or choose a telescope based on the Moon, or perhaps one on Pluto. You can view the skies from a telescope on any planet in our solar system or on any of the planets' moons. And, as if this weren't enough, the telescopes are mobile so that you can specify the exact latitude and longitude of any viewing location you want.

Because all this is done remotely, with the images beamed to your spacecraft, you won't ever see the telescopes or their observatories. But you do get to fully control the instruments, choosing what you want to view and then adjusting the zoom to alter your powers of magnification.



TECH TIP

Before you go to the observatory, save your current situation (perhaps naming it something like BOOKMARK) if you want to resume your spaceflight later at the point where you left off.

MISSION: Watching Mars from Phobos

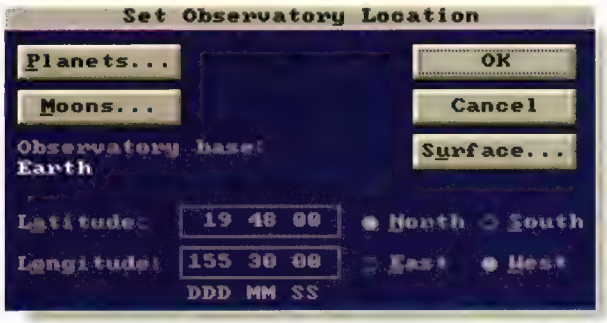
You'll feel like a true master of the universe in your spacecraft as you fill the cockpit window with a live image of Mars as seen from your observatory on the planet's tiny, potato-shaped moon Phobos. You'll experience a sense of being rather omnipotent—or at least omnipresent—as you watch Mars move through its rotation and its phases of dark and light at one end of our solar system while you might be blasting around another corner of the galaxy. And you can use the same principles for a vast array of intriguing observations.



Mars as it would appear from Phobos.

Observing Mars

1. Choose the Observatory command from the Options menu.
2. Choose the observatory location display on the instrument panel to open the Set Observatory Location dialog box (shown on the next page).
3. Choose the Moons button. In the Moons dialog box, select Phobos and choose OK. If you want to specify an exact latitude and longitude for a location on Phobos, you can enter the coordinates in the Set Observatory Location dialog box. If you don't want to use this option, simply choose OK to close this dialog box. On the observatory instrument panel, Phobos is now set as your observatory location.



4. Press the T key or choose the target display on the instrument panel to open the Select Target Object dialog box.
5. Select the Planets option button, select Mars from the list, and choose OK. On the observatory instrument panel, Mars is now set as your target object.
6. Press the F1 key several times to speed up the passage of time; begin by experimenting with 2 minutes per second, and then change the rate as you choose, to see Mars move through its phases.
7. Try adjusting the zoom setting to get a closer or more distant view of the planet.

The observatory provides great entertainment, especially when you're making a long passage. For instance, using the techniques just described for observing Mars from Phobos, set the observatory location for the moon Callisto, the most distant of Jupiter's Galilean moons, and set Jupiter as the target object. Advance the time scale to about 9 hours per second, and watch the other moons dance around Jupiter as this huge planet performs its own slow waltz around the Sun. Or you can see a beautiful vista of Earth by setting the observatory location for Earth's Moon and setting Earth as the target object. When you do this, you can observe Earth moving through phases that are much the same as those we see the Moon move through when we view it from Earth.



TECH TIP

Be sure that you're using tracking instead of panning as your viewing method so that the target object remains centered as you accelerate the time scale.



TECH TIP

When viewing Earth from the Moon, open the Time dialog box and set the date for 01 Feb 1997 and the time for 08:00:00. Use the Preferences command from the Options menu to turn on labels for planets. When you pan a little to the right, you'll see six planets on the screen.

Slewing the Telescope

To put you in control, the observatory instrument panel also lets you slew these remote telescopes regardless of where they are placed. If you want to slew a telescope, use panning rather than tracking as your viewing method. Tracking keeps the target object centered on the screen, whereas panning lets you slew your telescope using the rotation keys.

Here the meaning of the term *slew* is quite different from the term *slew control*, which refers to one of the methods you can use to fly your spacecraft. In this case, *slewing* refers to moving a telescope to aim it at a new object.

A telescope's movement and position can be measured in two ways: right ascension and declination (RA/Dec), and altitude and azimuth (Alt/Azi). Both methods are analogous to the surface-based measurements of latitude and longitude. Declination and altitude are similar to latitude; right ascension and azimuth are similar to longitude.

The primary difference between the two methods is the reference point you use. RA/Dec maps its "longitude" and "latitude" onto the celestial sphere, an imaginary globe surrounding Earth (or wherever your observatory is currently located) whose axis and equator match those of Earth. Alt/Azi, however, uses an axis that runs vertically through your telescope and an equator that matches the horizon.

Of the two ways of measuring a telescope's position, Alt/Azi is the simpler. However, astronomical distances are usually expressed in terms of RA/Dec coordinates.

To control the movement of your telescope, choose the control display in the lower right corner of the observatory instrument panel to cycle through the Alt/Azi, RA/Dec, and panning methods. The panning option lets you look around the skies without changing the view direction that has been dialed in using the RA/Dec or Alt/Azi setting.



TECH TIP

The speed of the clock drive is automatically set to match the rotational speed of the planet or moon you choose for your observatory location.

You can also use the clock drive to adjust and control your telescope view. A clock drive is a small motor on a telescope mount that provides an offsetting rotation to counteract the rotation of a spinning planet. It helps you keep an object in focus instead of letting it drift from view. Choose the clock drive display on the instrument panel to toggle the clock drive on and off.

When the clock drive is off, an object drifts from view more rapidly when the zoom values are higher. This parallels the effect you see through a real-life telescope when you increase the magnification and hence create a smaller field of view. The field of view readout on the instrument panel adjusts whenever you change the zoom factor.

ASTRONOMICALLY SPEAKING
Planets in the Nursery

The famous Hubble Space Telescope orbits Earth and has a clearer view of the heavens than land-based telescopes. After some successful in-orbit repairs, the Hubble began to transmit stunning photos back to astronomers.

The vast hydrogen cloud of Orion has long been known as a place where new stars are born. Now the Hubble telescope has found hints of some surprise infants within the great stellar nursery of the Orion nebula, detecting signs of dust rings orbiting Orion's young stars. Although they have not found planets in Orion, astronomers believe that these dust rings might lump together over time to form planets, in the same way it is believed Earth might have been created.

The rings of dust, called protoplanetary disks, appear to be common among the stars of Orion, leading astronomers to speculate that planetary formation might occur frequently throughout the universe. The next question: On how many of these countless planets might life exist?



It's a Planetarium, Too

The observatory can also be a handy planetarium. A planetarium is a facility in which the movement of the stars and planets is shown across a domed ceiling. With Space Simulator, just select a surface location in the Set Observatory Location dialog box—the South Pole, for instance, or any of the other locations listed—and then set a time and date in the Time dialog box. In this way you can see what was happening in the sky at the moment of your birth or on any other historic (or future) date.



To enhance your planetarium view, press the L key to turn on labels—or be selective in what you label by using the Label Preferences dialog box. (See "Label Preferences," in Chapter 6, for more information about using labels.) For instance, you can turn on labels for constellations only. Then, in the Scenery Preferences dialog box, select Constellation Boundaries, and you'll be able to see where the various constellations are located in the sky on the date of your choice.

Once you've done this, it's fun to increase the time scale and swing your telescope up to Octans, where the constellations meet. Adjust the zoom to about 0.75, and switch to Full Screen view. Then choose an observatory location for the northern hemisphere and do the same to watch the parade of constellations around Polaris.

BEHIND THE SCENES
"Where Were You Traveling?"

Easter Sunday of 1994 began with me asleep on the floor of my office, as two computers ran Space Simulator through the night. Later that day I drove to my father's house to say hello. We sat in his lookout room, drinking coffee and watching huge black and blue clouds dump torrents of rain across the waters of Puget Sound.

"Where were you traveling this morning?" he asked.

"Just down from Redmond," I started to say, when I realized what he was really asking. And then I thought: "Wow! My dad really gets it! My father, who didn't buy his first computer until age 70, and who every now and then flies Flight Simulator, really understands what this is all about!"

So I told him about flying to the star Altair. He asked how far away it was, and I said about 16 light-years. I described arriving at the star Saturday night, visiting its first planet, and leaving the computer on all night and all day as I headed toward the second planet in the system. He wanted to know how fast my ship was traveling while I was away, and I replied, "About 9,000 miles an hour."

As I drove back to Microsoft that night, his question kept running through my head—a question that opened the door to the very heart and charm of the Space Simulator world: "Where were you traveling?"

Diving into Some Daring Missions

Space Simulator comes with two formal missions, but to be honest, I have never cared much for either one. When I want to have fun out in space, I create my own missions as well as try out adventures that have been conceived by others. What follows is a collection of missions that I find intriguing. I hope that you enjoy them and that they inspire you to set off on missions of your own.

Collecting favorite missions from members of the Space Simulator team was rather like conducting personality tests. Different people seemed to want different experiences from the world of Space Simulator. (My own suggestions ran from the most dangerous, Playing Chicken with the Black Hole, to the hands-down nerdiest, Charting the Globular Clusters.) I've divided these missions into four categories: some of them seek to beat the clock, and others are just plain dangerous; some are exercises in colonization, and still more should pose an intellectual challenge.

"Start the Timer" Missions

These four missions can be fun and challenging, especially when you time how long it takes to accomplish them. Space Simulator doesn't have a built-in stopwatch, but you can use the Time dialog box to set your system time to 00:00:00 and then press the Pause key to freeze time until you are ready to begin. Or you can do it the easy way and just jot down the time from your wristwatch or other real-world timekeeping device.

MISSION: Threading the Needle

BACKGROUND: As you sit in the Tolkien Trilogy Bar aboard Ring Station 1, sipping a Galactic Guzzle, you're listening to someone who claims to be a wizard at steering the manned maneuvering unit. Being no slouch yourself, you accept a challenge to see how fast you can complete a "thread the needle" circumnavigation of Ring Station 1—an activity that is officially frowned on but discreetly allowed.

THE MISSION: First jot down your starting time. Then, inside your MMU, undock from Ring Station 1 and travel up to the top of the station, passing between the powerful spokes of the two rings ("threading the needle"). When you reach the

top, fly across the cargo bay and back down to the docking port, threading the needle a second time. Dock with the station again, and then check your finishing time. How long did it take?

VARIATIONS: Try this mission first in slew control and then in flight control. You can also experiment with skill level settings.

HINTS: To get started, dock with Ring Station 1 while flying the MMU. To automate this setup, choose the Spacecraft command from the Flight menu, and select Manned Maneuvering Unit. Then use the autopilot's Dock action, with Ring Station 1 set as the destination. Try not to get hit by the spokes of the ring station—they carry a lot of momentum!





TECH TIP

To go to Space Station Freedom, you must choose the Open Situation command from the Options menu and then select one of the situations that feature this space station, such as 1999, PATROL5, or PANEL. You can't reach Space Station Freedom through the Location menu unless you start with one of these situations.

MISSION: In from the Cold

BACKGROUND: The captain of your shuttle says you can choose the music that's played all the way home if you'll go out and inspect the solar panels of Space Station Freedom.

THE MISSION: Write down your beginning time, and then fly the MMU from the shuttle clear around Space Station Freedom. Pass outside all ten of the station's blue solar panels, and then fly into the shuttle's cargo bay. Check your finishing time to see how long it took.

VARIATIONS: Experiment with both slew control and flight control as well as with different skill level settings. Try "walking the rails," flying along the complete length of Freedom's central girder support.

HINT: Begin by opening the situation PATROL5.

MISSION: Parking Test

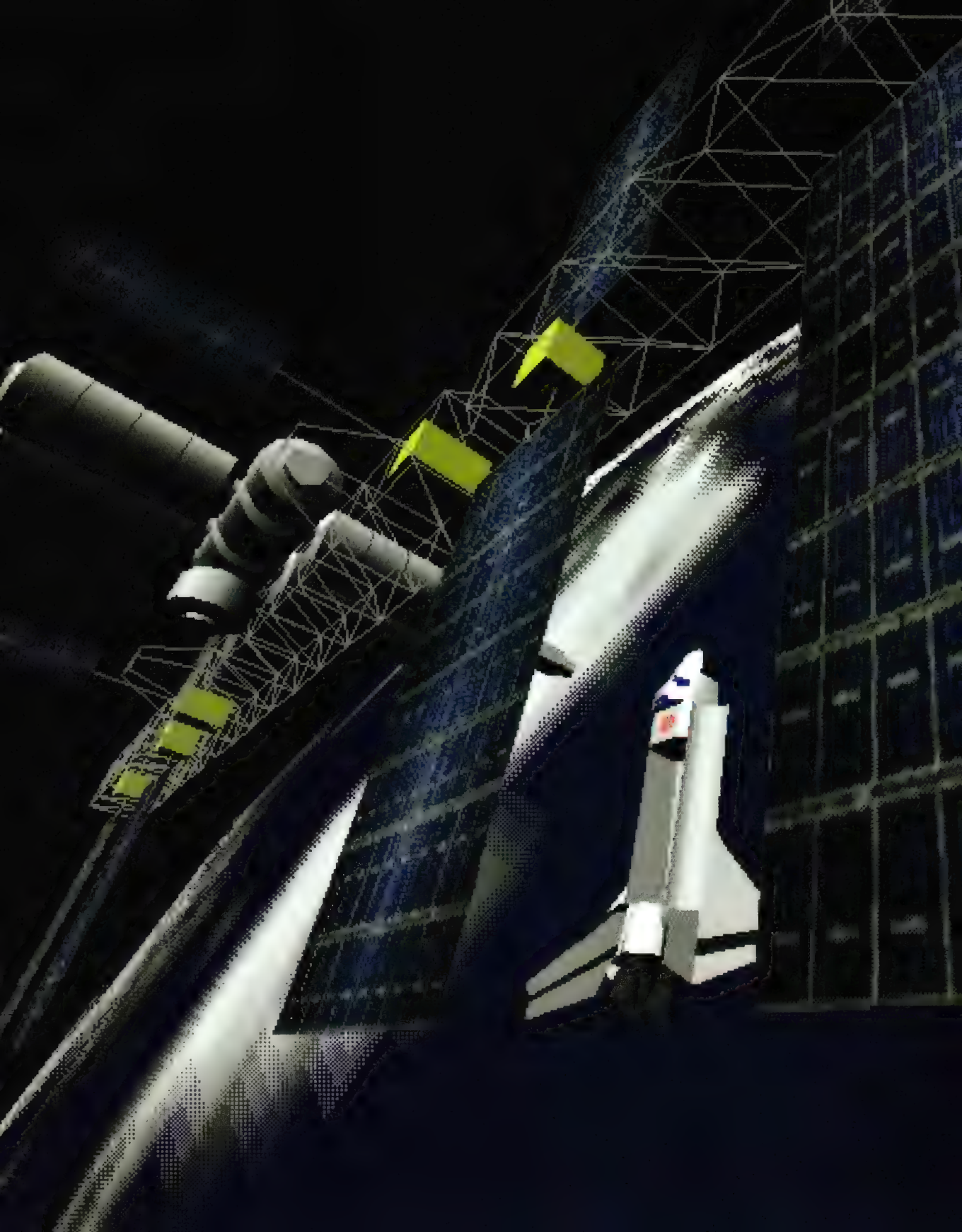
BACKGROUND: Any starship master can tell you that piloting across 30 light-years of empty space is a cinch compared to docking with a space station when you arrive at your destination. The ships are big and expensive; the space stations are even bigger and more expensive. And space doesn't treat accidents nicely. All space cadets must at some point endure the infamous "parking test." How quickly can you dock . . . and how gently?



THE MISSION: Dock the Zander Freighter with the Lunar Orbiter space station. How long does it take? How low can you keep your radial velocity when joining with the docking port?

VARIATIONS: Try docking the F-79. (Its docking port is located beneath the cockpit.) Vary the skill level setting. Then try docking different ships with either the Mars Orbiter or Ring Station 1.

HINT: You'll want to practice this mission and its variations using slew control for a while, to hone your skills, before trying it in flight control.





ASTRONOMICAL NOTE

Saturn has a rich array of moons. Astronomers on Earth were able to discover nine moons; space probes flying past the planet have found and photographed an additional eleven. Most of these moons are believed to have huge deposits of water ice—two of them, Hyperion and Iapetus, might in fact be composed almost completely of ice.

MISSION: Saturn Giant Slalom

BACKGROUND: Roger Pettibone, a Space Simulator tester and a longtime space-development enthusiast, created this mission. His concerns for realism and conserving fuel make this a tough but intriguing challenge.

THE MISSION: First write down your starting time. From your starting point, a 4-radii orbit of Saturn's moon Phoebe, fly the All Terrain Lander to within 50 kilometers of the surface of the moons Iapetus, Hyperion, Titan, Rhea, Dione, Tethys, Enceladus, Mimas, and Janus, working your way inward. You can modify the time scale, but you must stay in flight control, and you cannot refuel before the end of the mission. You reach the "finish line" as you close to within 50 kilometers of Janus. How long did it take? And how much fuel do you have left?

VARIATIONS: Fly among the moons of Altair's planets or those of the other solar systems you can find through the Location menu. Try using different ships for the mission.

HINTS: Label Saturn's moons to identify them. To begin your journey with a full tank of fuel, fly to an orbit around Phoebe in the Galactic Explorer, and then choose the Deploy Lander command from the Flight menu. (Remember that you must fly this mission in flight control; in slew control, no fuel is ever used.)



The ATL dives toward the "finish line" near the moon Janus.

The key to this mission is to let orbital mechanics work with you. If you try to blast away with brute force and simply chase objects down, you probably won't get beyond the first moon before running out of fuel.

"Daring But Dangerous" Missions

If you get into trouble while flying one of these missions, just remind yourself that it is all a simulation and that you really haven't become hopelessly lost in space . . . and that you really aren't being sucked into a black hole . . .

MISSION: Riding the Wild Horses of Space

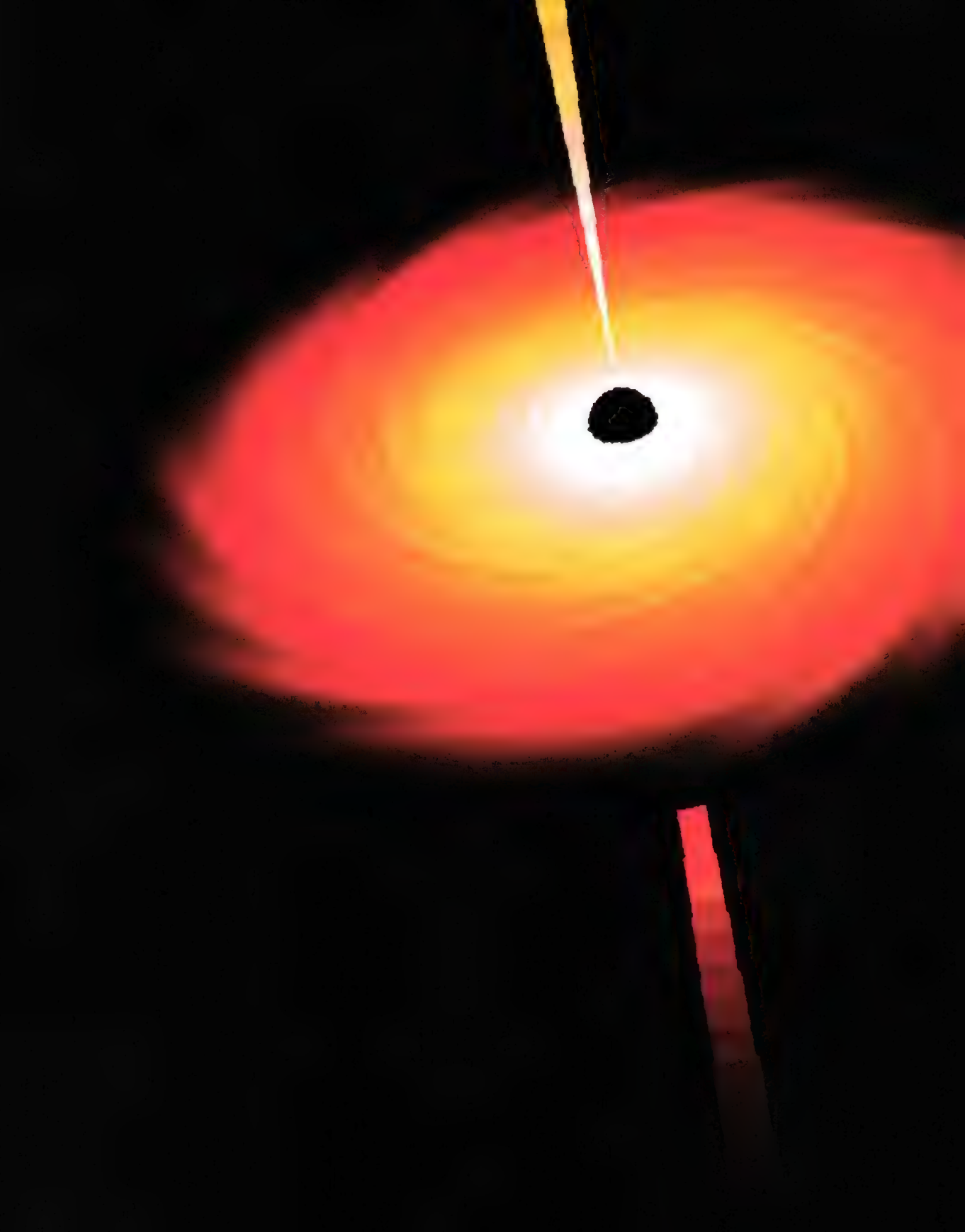
BACKGROUND: Although Tom Sperry is a tester for Flight Simulator rather than Space Simulator, he liked to stay late at night traveling through space. Something he'd often do was to max out thrust in slew control, max out the time scale (8,710.5 years per second), and then try to control his spacecraft through a series of wild maneuvers around the galaxy. He called this "riding the wild horse."

THE MISSION: In slew control, press F8 to produce maximum thrust, and press F1 until you reach the maximum time scale setting. Head for the core of the Milky Way (avoiding the black hole!), and have fun flying around the galaxy, riding the wild horse.

VARIATIONS: Fly loops around the entire galactic plane. Race completely around the galactic perimeter, circumnavigating the Milky Way. See how far out you can fly, away from the galaxy, without losing track of that beautiful swarm of stars. It's always eerie to lose track of the entire galaxy—a reminder of the incomprehensible vastness of the black sea in which our home galaxy floats.



HINT: This mission has a time limit, just as if you were riding a wild horse in a rodeo. Eventually a Simulation Error message box will appear, informing you that "Space Simulator cannot continue the simulation more than 5 million years into the future."



MISSION: Playing Chicken with the Black Hole

BACKGROUND: A black hole is caused by a star that has collapsed of old age, after consuming all its hydrogen and helium fuel for nuclear fusion. Its mass remains, but with the "furnace" extinguished, the star collapses in on itself, becoming incredibly dense, compressed to hundreds of millions of tons per single inch.

For sufficiently massive stars (those at least one and a half times the size of our Sun), the compression of matter becomes so extreme that atoms are packed together, nucleus to nucleus. The result is a source of gravity in which the gravitational acceleration exceeds the speed of light. When this happens, not even light can escape the ex-star's gravity well. It's believed that black holes are rather common throughout the universe, despite their exotic nature.

"The number of black holes may well be greater even than the number of visible stars, which totals about a hundred thousand million in our galaxy alone."

— Stephen W. Hawking
A Brief History of Time

THE MISSION: See how closely you can approach a black hole before your spacecraft is captured by its gravity. Move to the black hole either by opening the ORBITCOR situation or by choosing the Deep Sky command from the Location menu and selecting Galactic Core.

VARIATIONS: Ease your ship nearer to the black hole by applying retrograde thrust to slow your orbit around the black hole. For a quicker slide into oblivion, press F4 to cancel existing velocity, press F1 to speed up the time scale, and watch the increase in the radial velocity readout.

A fascinating variation is to allow your ship to be pulled into the black hole and then shot out the other side. You can monitor your velocity as it approaches the speed of light. After you've been blasted through, increase the time scale to 68.1 years per second and watch the galaxy become a spiral disk behind you as you head for realms unknown.

HINTS: Don't try this mission in the Zander Freighter or the Bussard Ram-Jet, whose top-end acceleration is only 2 Gs. The ATL exerts only 3 Gs, while the Callisto and the Galactic Explorer can accelerate at 4 Gs. The real star of this daring show, however, is the F-79 Galactic Fighter, which can exceed the instrument panel's limit of 4 Gs and can exert 8 Gs. Be warned, though, that the value of even 8 Gs can evaporate quickly when you are being drawn toward a black hole.

"Empire Building" Missions

As the dwellers of Earth venture farther into space, it will in part be to create new outposts of humanity so that all of life as we know it isn't stranded on a single planet. Although Space Simulator hasn't been specifically geared up for such colonization, you can take some heroic first steps.

MISSION: Colonizing Space

BACKGROUND: From the beginning of the project, members of the Space Simulator team were always looking for ways to gather together the program's ships and stations, perhaps to fend off the existential loneliness of space. In doing so, we learned how to use the product in ways not originally intended, which provided an extra sense of adventure. The Location menu turned out to be key.



THE MISSION: Create your very own space colony with this strategy: First dock your spacecraft with a space station, choose the Vehicle Transfer command from the Flight menu, and then transport both objects to an area of space that you want to colonize, using either the Location menu or seat-of-the-pants piloting. When you arrive, choose the Vehicle Transfer command again (returning control to your ship), undock the craft, and deploy the lander. Fly the ATL as you go off in search of the next station you want to add to your growing "Orbitsville."

After docking with this new space station and again transferring control, choose the Spacecraft command from the Location menu and select the ship you left behind at your new orbiting village. This will immediately return you to the colony. Continue using this method to expand the colony, saving the situation as you progress.

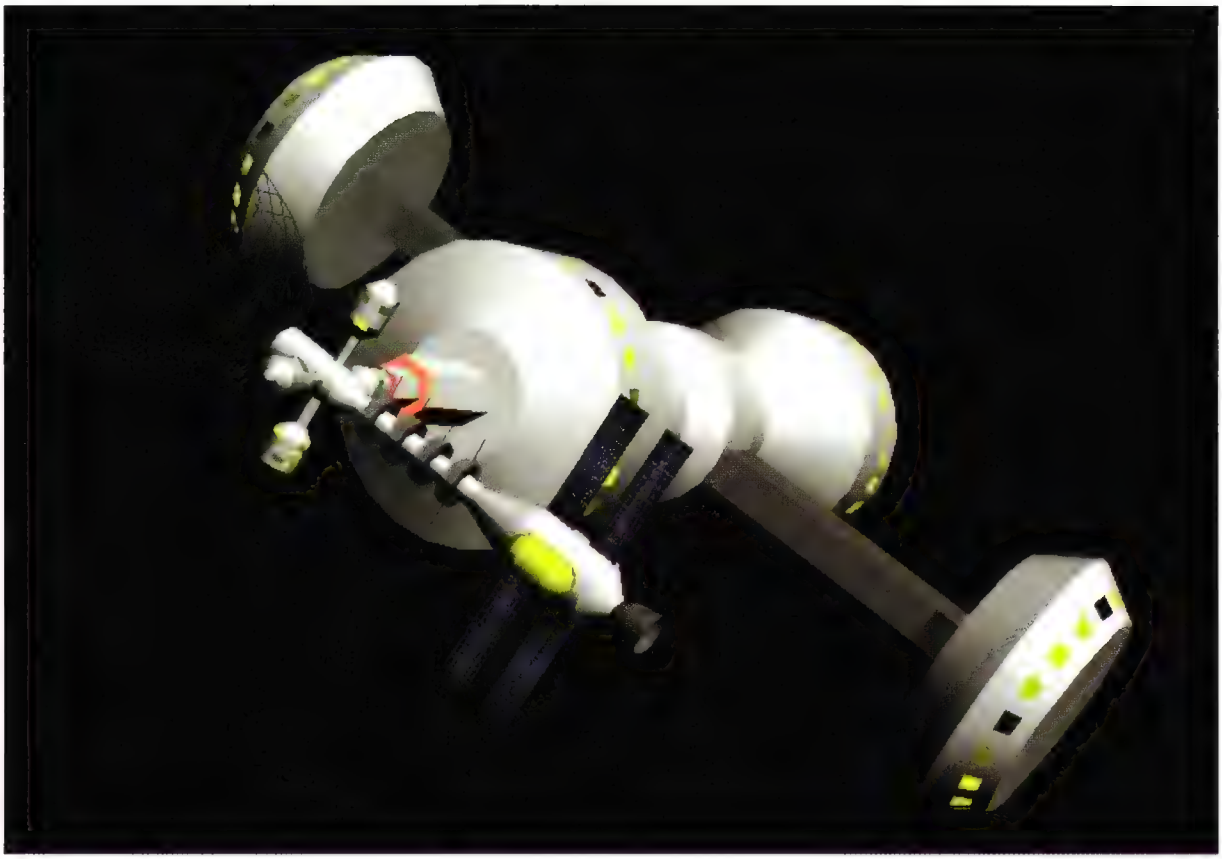
VARIATIONS: How many space stations can you assemble in one location? How many ships can you transport to the colony?

HINT: An interesting trick is to "morph" your ship, which means changing one ship into another. For instance, let's say you've moved the Lunar Orbiter and the Mars Orbiter space stations to your new colony, while flying the Galactic Explorer. You could deploy the All Terrain Lander and then morph the ATL into another ship by choosing the Spacecraft command from the Flight menu and selecting, for example, the Bussard Ram-Jet. Presto—two space stations and two large ships, all on your screen at the same time. And then you can send out the MMU from the Ram-Jet and morph it into a third ship!

MISSION: Creating Your Own Getaway (and Gas Station)

BACKGROUND: Space Simulator offers 19 additional solar systems, all of them accessible by choosing a star from the Location menu. Once you've traveled to a new star, you can use the Location menu to journey to the planets and moons of the star's solar system.

THE MISSION: Go out exploring! There's a lot of untracked ground out in space—visit the other solar systems, find a planet or moon you like, and create your own private getaway by moving a space station into position to keep yourself



comfortable (and your ship filled with fuel). Since docking with a space station automatically refuels your ship, it is handy to keep a station around!

VARIATIONS: Try this mission with one new planet and moon after another. Save each adventure as a situation for an easy return. See how many space stations and spacecraft you can collect in one place.

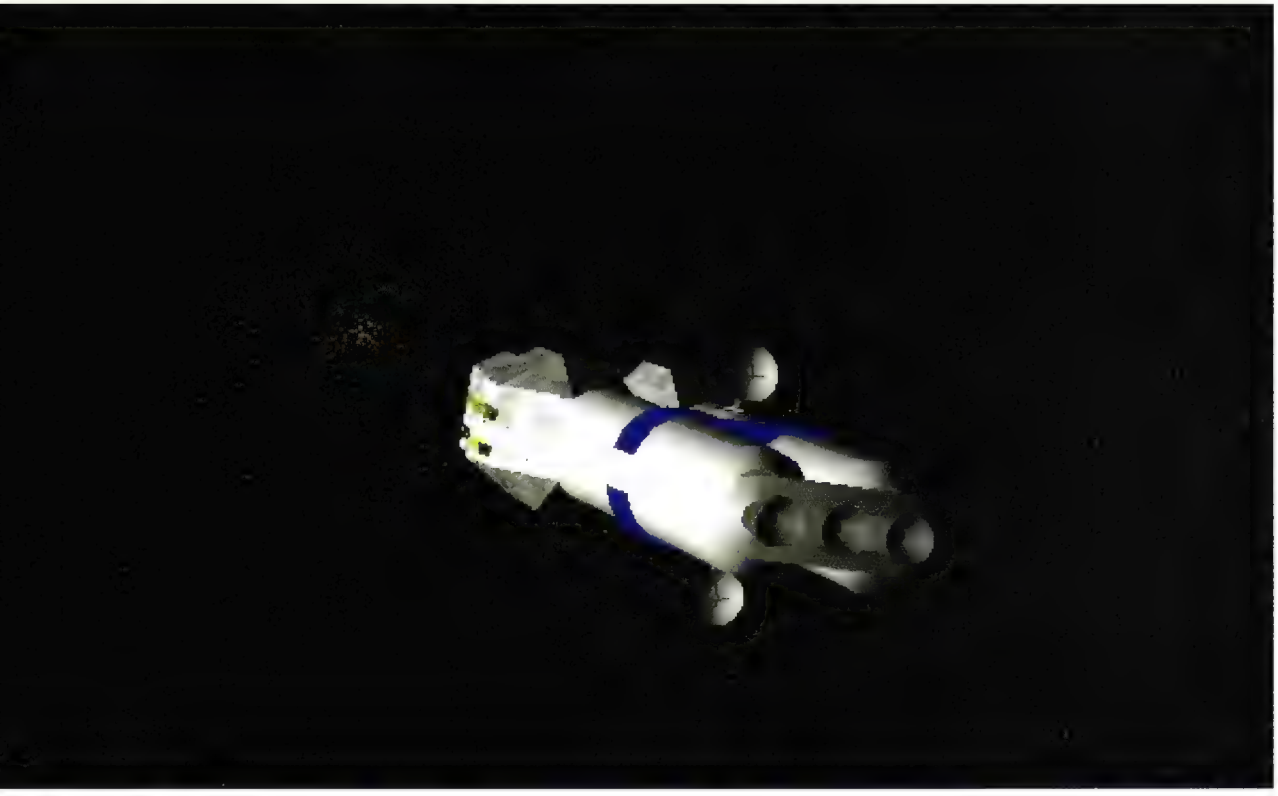
HINT: You can borrow a space station and move it to a new location using the techniques described in the Colonizing Space mission.

"For the Curious" Missions

Some missions are simply fascinating rather than being flashy or dramatic. Yet such missions can take you deep into the mysteries of space.

MISSION: Charting the Globular Clusters

BACKGROUND: I've always had an interest in exploring the globular clusters that are found within Space Simulator's Milky Way. Globular clusters are the tightly packed balls of yellow and orange stars that are generally found just above or below the galactic plane. With the time scale jacked up to a few hundred years per second, I like to travel through the center of a cluster, watching it expand as my ship grows closer.



Some years ago, while writing a book on astronomy, I met an amateur astronomer who each night scanned the Milky Way searching for a nova, a single new star that could have appeared anywhere in the heavens. He had managed to memorize the Milky Way, clear down to the binocular level, by creating his own fanciful constellations, sketching them out, and giving them names like "Bamboo Yielding" and "Rollerskating Lion." It was a beautiful way to study the sky, and I think of this whenever I go exploring the globular clusters of Space Simulator.

THE MISSION: Here's a mission for the patient and for the inquisitive. Visit every globular cluster you can find in the Milky Way. Once inside a cluster, slow the time scale or press the Pause key to give yourself some time to look around. You can make some sketches if you like. If your imagination picks out some constellations within the cluster, try naming some of them.

VARIATIONS: After you've visited all the globular clusters, go out looking for other interesting star formations. Remember that whatever you find you can claim for yourself; just save and name the situation.

HINTS: This mission is best flown in slew control. Press F8 for full thrust and an immediate velocity that is nearly the speed of light. Head for the galactic core, pick out a globular cluster, and steer right through its center. To preserve your discoveries for a later return, save the situation or record the readings on your instrument panel.

MISSION: In the Steps of Voyager 2

BACKGROUND: Though it is manned spaceflight that most vividly captures the public's attention, many robotic spacecraft (less imaginative types call them "unmanned") have been voyaging through space and transmitting their findings to Earth, ranging from breathtaking photographs and scientific measurements to the discovery of new moons.



ASTRONOMICAL NOTE

Even though Voyager 2 was launched back in 1977—and even though it was 41 AU from Jupiter in 1994—the space probe was nevertheless able to record observations as Comet Shoemaker-Levy 9 crashed into Jupiter in mid-1994. Pretty amazing.

THE MISSION: Retrace the steps of that lonely robot Voyager 2, which presented humans with years of wondrous findings before departing the solar system for points unknown. With the Time dialog box, you can step back in time to the milestones in Voyager 2's travels: It was launched August 20, 1977; reached Jupiter July 9, 1979; visited Saturn August 26, 1981; flew to Uranus January 8, 1986; and finally reached Neptune August 24, 1989.

VARIATIONS: Retrace the travels of Voyager 1 as well as other great probes such as the Mariner series, Pioneer, Magellan, or Galileo.

HINT: Books from your local library or bookstore can provide exacting maps of the space probes' passages, including slingshot maneuvers and scientific detours.

MISSION: The Visions of Ptolemy

BACKGROUND: The mathematician Claudius Ptolemy lived more than 17 centuries ago. So it is understandable that he saw Earth as the center of the universe, with the Sun and all the other heavenly bodies circling Earth. Ptolemy explained away the problems of retrograde planetary movement—why planets at times appear to reverse direction—with his theory of "epicycles," in which each planet moved in a circle, while the circle rotated around Earth. He was wrong, of course, but his theories stood as fact for more than a dozen centuries, until they were undone by Copernicus.

THE MISSION: View the heavens through the eyes of Ptolemy. To accomplish this, start by choosing the Arrange command from the Window menu, turning on Map view, and turning off View 1, View 2, and the instrument panel. Set Earth as the origin of your map. In the View Controls dialog box, turn off all the objects listed in the Show On Map section except planets.

To display the inner planets, press the minus sign key several times to adjust the map scale to 7.53 AU. Press F1 several times until the planets begin moving, leaving their tracking trails behind. You'll clearly see the corkscrew "epicycles" evident when one studies the heavens with Earth as the center.

VARIATIONS: Create a Jovian-centered universe with Jupiter set as the map origin. Then create a Martian-centered universe. Work your way through the planets, and then try this with different solar systems.

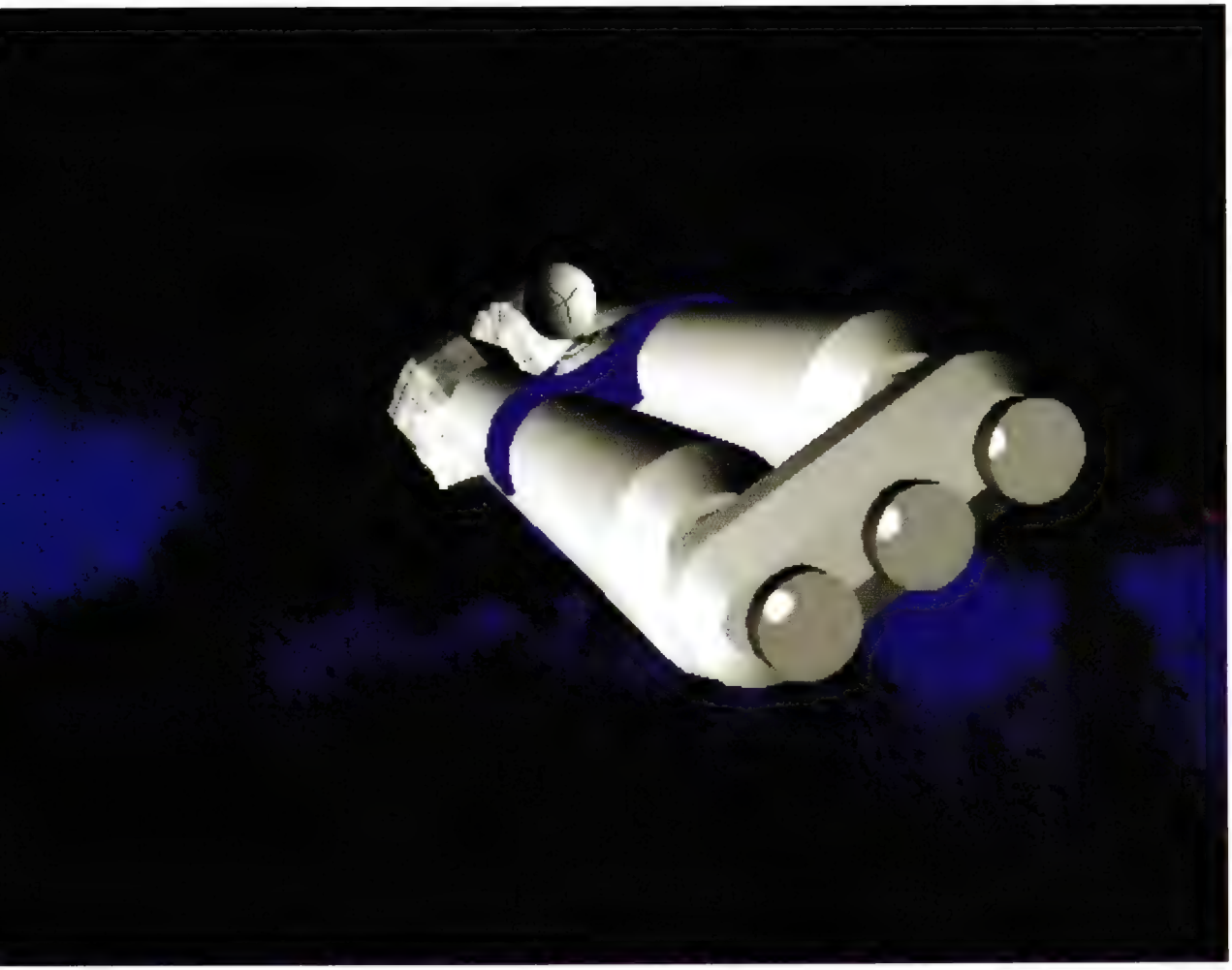
HINT: Increase the map scale to 15.05 AU, and Jupiter will put on an especially good show for you.

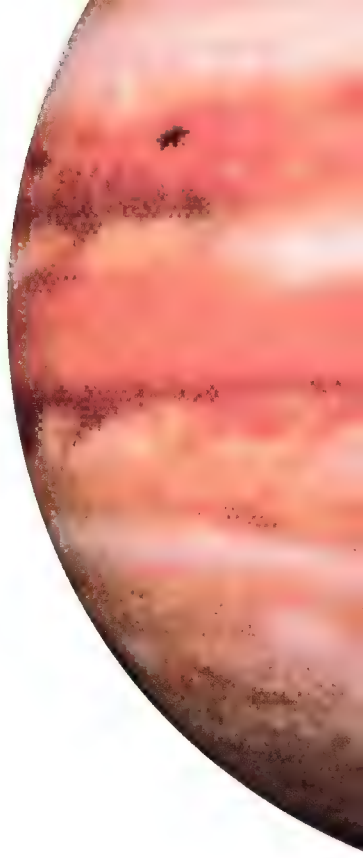


The Never-Ending Mission: Explore, Have Fun, and Don't Forget to Write!

This book—but not your Space Simulator adventure—is drawing to a close. I'm saying farewell, waving at your great ship as you undock, back away from the station, turn the spacecraft's nose toward a destination somewhere out *there*, and move into the distance.

Soon I'll climb back into my ship, too. Despite the vastness of space, who knows whether we might someday meet in orbit around a planet that hasn't yet been found? Until then, explore! Have fun! And don't forget to write!





A

absolute chase craft perspective, 56–57, 179
acceleration. *See also* thrust
  defined, 34
  gauge, 13, 14, 34
  and Newtonian mechanics, 34, 35
Adams, John Couch, 52
Advanced skill level, 79, 106, 201
aerobraking, defined, 206
Aldebaran, 119
All Terrain Lander (ATL)
  atmospheric entries with, 201
  described, 77, 224
  docking, 77–82
  exploring Cybele with, 128
  flying, across rings of Saturn, 171, 173
  flying, among Saturn's moons, 220–21
  flying, close to Ring Station 1, 77–79
  flying, into Ring Station 1 cargo bay, 91
  landing, at Cape Canaveral, 205–6
  undocking, 115, 159
  when to use, 110, 115
Alpha Centauri, 40–42, 167–69
Altair, 109, 215
altitude, 77, 201, 202, 212
  vs. distance, 113, 124, 126
Ambient Light settings, 99
Andromeda galaxy
  described, 116
  as destination, 111, 116
  flying to Earth from, 116–18
  viewing, 51
Antares, 109
apogee
  defined, 207
  monitoring readouts, 208
  and retroburns, 209
Arcturus, 140
Arrange command, 63–66
Arrange Windows dialog box, 63–66
artificial intelligence, 155
Artwick, Bruce. *See* Bruce Artwick Organization (BAO)
ascension, right, 212
assembly language, 58
Assigned view
  and docking, 67
  and Mars Orbiter mission, 59–60
  when to use, 58, 68–69, 91
asteroid belt, 110
asteroids
  defined, 110
  traveling to, 126–28
Asteroids command, 110
astronomical units, defined, 118
Atkinson, Brooks (*Once Around the Sun*), 179
ATL. *See* All Terrain Lander (ATL)
atmospheres
  modeling the effects of, 202
  of moons and suns, 202
  of planets, 204
atmospheric entries
  calculating, 201–2, 204
  at Cape Canaveral, 205–6
  practicing, 204–6
atmospheric skipping, 206
attitude display, 15–16. *See also* pitching; rolling; yawing
autopilot. *See also* flight computer; *and names of specific autopilot actions*
  actions available, 153–54
  canceling an action, 154
  creating, 160
  defined, 152
  destination for an action, 156–57
  duration of an action, 159
  executing an action, 154, 155
  orbital radius for an action, 158
  saving an action, 155
  and time scale, 160, 170
Autopilot dialog box, 153–55
azimuth, 158, 212

B

base objects, for Set Location command, 123–25
Betelgeuse, 41, 109

black holes, 223–24
.BMP files, 174, 182
Boeing 747 training simulator, 18
bookmarks, saving situations as, 134
boundaries, constellation, 97, 215
braking. *See* aerobraking, defined; thrust
Bruce Artwick Organization (BAO), 6, 100
Burroughs, Edgar Rice, 194
Bussard, Robert, 138
Bussard Ram-Jet, 138, 139, 224
BUSYSKY situation, creating, 147–50

C

Calder, Nigel, 40
calibrating joystick, 25
Callisto (moon), 35, 57, 211
Callisto (spacecraft), 164–66, 169
camera, using, 174–75
Camera dialog box, 174–75
Cape Canaveral
  as destination, 110, 199
  landing at, 204–6
cargo bay, exploring, 89–91
centering panning bars, 48, 112
Ceres asteroid, 110
chase craft distance, 55, 84, 179, 180
chase craft perspective, 56–57, 179
Chase Craft view. *See* Chase view
Chase view. *See also* chase craft distance; chase craft perspective
  chase craft position in, 56
  and Cockpit view, cycling between, 16, 57–58
  defined, 16
  enhancing, 54–57
  flying between Ring Station rings in, 20
  and tracking objects, 144–45, 146
Choi, Rich, 196
choosing commands, 3
choosing displays on instrument panel, 42
circularizing orbits, 208
Clementine spacecraft, 166
clock drive, 213
Close button (view tools), 47, 49
Clouds On Planets check box, 98
clusters, globular, 6, 108, 228–29
COASTAL situation, 7
Coast autopilot action, 154, 159, 160, 170
COASTER1 flight plan, 166
Cockpit view
  and Chase view, cycling between, 57–58
  defined, 16
  enhancing, 48–51
  and head-up display, 112, 113
combined velocity, 35. *See also* velocity
comets, defined, 109
Comets command, 109
Comet Shoemaker-Levy 9, 229
Complex detail option, 90, 99, 178
Constellation Boundaries, as scenery option, 97, 215
constellations, labeling, 215
control readout, 22
coordinates, for latitude and longitude, 124
coordinate systems, for Space Simulator, 92
Copernicus, 230
Crab nebula, 108, 111
customizing
  keyboard, 104
  labels, 101–3
  precision settings, 94–95
  rendering, 98–100
  scenery, 96–98
  screen, 63–71
  skill level, 106
  sound, 106
  Space Simulator, 93–106
  view windows, 66–71
Cybele asteroid, flying to, 126–28
Cygnus constellation, 6

D

darkness. *See* light
data structures, for Space Simulator, 92
dates, changing, 43–44, 113, 211

declination, 212
Deep Sky Objects dialog box, 111
deep sky objects, 108
Deimos (moon)
  described, 109
  flying from Phobos to, 112–15
DEL command (MS-DOS), 169
deleting
  flight plans, 169
  situations, 133
  video recordings, 185
Del keys, multiple, 79
deorbit burn, 204, 209
Deploy Lander autopilot action, 153, 154
Deploy Lander command, 77. *See also* All Terrain Lander (ATL)
descriptions, of situations, 132, 134–35
destinations, linking autopilot actions to, 156–57. *See also* Location menu
Detail settings, 90, 99, 178
dialog boxes, navigating, 23
digitized music, 106
DIR command (MS-DOS), 169
Direction button, 47, 61–63, 66. *See also* panning; tracking
disk caching, 195
distance
  vs. altitude, 113, 124, 126
  chase craft, 55, 84, 179, 180
  in space, 116, 118
distance readout, 31, 42
Dithered shading option, 98–99, 100, 178
Dock autopilot action, 153, 154, 156
docking
  ATL, 77–82
  Galactic Explorer, 79
  and skill levels, 106
  universal port for, 81
  view of, 81
docking port camera, 67
doubling speed of time scale, 41
Drake, Frank, 151
Drexler, Eric, 7
duration of autopilot actions, 159

E

Earth
  backing away from, 86–87
  as center of universe, 230
  described, 9
  flyby, in panning mode, 62
  flyby, in tracking mode, 63
  flying from Andromeda to, 116–18
  returning to orbit of, 11, 13
  viewing, during reentry, 7
  viewing, from Moon, 211
  viewing, from space, 9
  viewing, without cloud cover, 98
editing
  flight plans, 166
  video recordings, 187
Einstein, Albert, 40
elongating orbits, 208
Europa (moon), 35
Europa asteroid, 110
Event Duration dialog box, 159

F

F-79 Galactic Fighter, 199, 201, 204, 224
Faceted shading option, 90, 99
filters, in Open Situation dialog box, 133
fine thrust. *See also* thrust
  canceling, 75
  defined, 75
  and flight control, 84–85, 86
  flying ATL with, 77–79
  flying MMU with, 83–85
  forward and backward, 75, 77
  for landing, 206
  left and right, 79
  and slew control, 85–87
  upward and downward, 78–79
fine thrust gauge, 75, 77–79
flight computer. *See also* autopilot; Flight Computer dialog box; flight plans
  creating, 160
  defined, 152, 161
Flight Computer dialog box, 161–63

flight control
  controlling velocity in, 35
  and fine thrust, 84–85, 86
  gravitational pull in, 39
  vs. slew control, 32–33
Flight Control command, 28, 32
Flight menu, 28, 31. *See also names of commands on this menu*
flight plans
  building on, 167–69
  creating, 162–63
  deleting, 169
  executing, 163, 165
  modifying, 166
  real-time, 170
  saving, 163
  size of, 167
  solar system mission, 164–66
Flight Simulator, 22, 26, 28, 104
FLIGHT situation
  backing away from Earth, 87
  customizing, 138–39
  exploring cargo bay, 89–91
  flying to Alpha Centauri, 40, 41
  flying MMU to Ring Station 1, 84
  returning to Earth orbit, 11
  slew control vs. flight control, 31–32, 33
  using fine thrust, 75, 77–79
  using panning and tracking, 50, 62–63
  using thrust, 13, 15
  using yaw, pitch, and roll, 16, 19, 20
Flight Situations filter, 133
flight yoke, 22
FLYABOUT situation, 144–45, 146
FORCHRIS situation, 129–30, 141–42
frame counter (for recording videos), 184–85
frame rate, 94, 95–96
framing photos, 176
Freedom. *See* Space Station Freedom
fuel supply
  of Bussard Ram-Jet, 138
  conserving, 220
  of Galactic Explorer, 60
  of MMU, 74
  replenishing, 60, 227
fuel supply, *continued*
  in slew control, 220
Full Screen view, 64, 66, 176
  recording videos in, 183

G

Gagarin, Yuri, 111
Galactic Explorer
  described, 60, 110
  docking, 79
  flying, by Lunar Orbiter, 144–45
  flying, into Ring Station 1 cargo bay, 91
  undocking, 115, 159
Galactic Fighter. *See* F-79 Galactic Fighter
galaxies
  Andromeda, 51, 111, 116–18
  defined, 108
  mapping, 72
  Milky Way, 151, 171, 221, 228–29
  Whirlpool, 111
Galilean moons, 35, 211
Galileo, 35, 173
Galle, Johann Gottfried, 52
Ganymede (moon), 35, 109, 135
Geller, Margaret, 72
Gibson, Edward G., 5
Gibson, William (*Count Zero*), 162
globular clusters, 6, 108, 228–29
Gouraud shading, 100. *See also* shading
gravities (Gs), defined, 34
gravity
  in flight control, 39
  freedom from, 28–29
  simulating, in space stations, 19
  in slew control, 38, 39
Greenwich mean time, 113
Guy, Charles, 6, 39, 82, 147, 151, 152
  on assembly language, 58
  on ATL, 77
  on autopilot and flight computer, 155, 160
  flies Boeing training simulator, 18
  on modeling atmospheric effects, 202
  on pitch control keys, 104
  on programming realistic simulations, 92

H

HAL 9000, 152
Hawking, Stephen W., 223
head-up display (HUD), 112, 113
Help menu, 29
Hendrix, Jimi (*Electric Ladyland*), 5
Hercules, 6
Holst, Gustav (*The Planets*), 5
horizontal panning bar, 47, 48, 50–51. *See also* panning; panning bars
Hubble Space Telescope, 122, 213
HUD (head-up display), 112, 113
Hyperion (moon), 220

I

Iapetus (moon), 220
inclination, orbital, 158
Ins keys, multiple, 79
Instruction dialog box, 162
instrument panel
  acceleration gauge, 13, 14, 34
  attitude display, 15–16
  choosing displays on, 42
  fine thrust gauge, 75, 77–79
  for observatory, 212–13
  in photos, 176
  reference display, 31, 42, 113
  rotation gauge, 15–16, 17, 18
  showing/hiding, 64, 65, 66, 176
  thrust gauge, 13, 14, 34
  time scale, 40, 41–42
  velocity readouts, 13, 14, 34
Intermediate skill level, 79, 106, 201
Io (moon), 35

J

joystick
  calibrating, 25
  flying with, 24–26
Joystick Preferences dialog box, 25
Jupiter, 109, 116, 229
  as center of universe, 231
  Map view of inner moons, 71
  moons of, 35, 57, 71, 109, 135, 211

K

keyboard
  controls, customizing, 104
  displaying key guide, 29
  flying with, 15–18, 19
  function keys vs. keypad keys, 29
  main, vs. keypad keys, 4
  rotating spacecraft with, 15–18, 19
  slew control keys, 29
Keyboard Guide command, 29
Keyboard Preferences dialog box, 104
kilometers vs. miles, 9

L

Label Preferences dialog box, 101–3, 215
labels, using selectively, 101–3, 215
Land autopilot action, 154, 156, 160
landing gear, 199, 206
Lassen, Chris, 129
latitude, 124, 204–5, 212
Launch autopilot action, 153, 158
launch azimuth, 158
Leverrier, U. J. J., 52
light
  adjusting, by changing longitude, 124
  adjusting, with Time dialog box, 43–44, 115
  adjusting, with time scale, 43, 177
  ambient, 99
  in photos, 177
light-years, 40, 41
limiting magnitude, defined, 98
Location button
  Assigned view, 58, 59–60, 67, 68–69
  Chase view, 16, 20, 54–58, 68
  Cockpit view, 16, 47–51, 57–58, 112, 113
  cycling between views, 16, 54, 57–58, 59
  described, 16, 47, 54
  displaying, 66
Location menu. *See also names of commands on this menu*
  commands on, 108–10, 123–25, 126
  described, 107–8
  using, 111–12



location tabs (panning bars), 47, 48, 112
longitude, 124, 204–5, 212
Looping Playback, for videos, 185, 195
Lunar Orbiter space station
  circumnavigating, 146
  docking Zander Freighter with, 218
  flying by, 144–45
  maneuvering around, in slew control, 37
  as tracking object, 144–45, 146

M

machine language, 58
Magellan space probe, 160
magnifying. *See* zooming
Mahler, Gustav, 5, 196
manned maneuvering unit (MMU)
  controlling, 74–75
  described, 74
  flying, in BUSYSKY, 150
  flying, into cargo bay, 89–90, 91
  flying, to Ring Station 1, 83–85
  at Space Station Freedom, 73, 218
  spacewalking, 5, 112, 115, 154
  "threading the needle," 216–17
  using fine thrust with, 83–85
Map Objects option (labels), 102
mapping galaxies, 72
Map view
  customizing, 67, 69–71
  Earth as origin, 230
  labels, 70–71, 102
  monitoring orbits, 207–8
  setting origin, 69–70
  showing/hiding, 64, 65, 66
Mars
  as center of universe, 231
  described, 141, 143, 194
  flying between moons of, 112–15
  moons of, 109, 112–15
  video, 189–95
  viewing, from observatory on Phobos, 209–13
Mars Base Marineris, 110, 115, 129–30, 141–42
  video, 189–95
Mars Orbiter space station
  lighting of, 177
  viewing, 59–60
Maximize/Restore button, 47, 49
maximum velocity, 36
Melville, Herman (*Moby Dick*), 173
menu bar
  displaying, 64
  opening menus from, 3
Mercury
  described, 166
  in TRIP1 flight plan, 164, 165
Microsoft Windows, displaying photos in, 174, 182–83
miles vs. kilometers, 9
Milky Way galaxy
  described, 40, 97, 108
  flying around in, 221
  globular clusters, 228–29
  as scenery option, 96
  sight of, 151, 171
MMU. *See* manned maneuvering unit (MMU)
MMU1 situation, 5
MMU-MARS situation, 141–42
MMUXPLOR situation, 190
monitoring orbits, 207–8
Mons Marineris, 143
Moon (Earth's)
  described, 145
  mining on, 145
  monitoring orbit around, 207–8
  polar craters on, 166
  viewing Earth from, 211
MOONDANZ situation, 3
moons
  described, 109
  of distant stars, 119–22, 170
  Galilean, 35, 211
  of Jupiter, 35, 57, 71, 109, 135, 211
  of Mars, 109, 112–15
  of Saturn, 3, 4, 220–21
Moons command, 35, 37, 109
Moravec, Hans, 19

"morphing" a spacecraft, 226
mouse
  adjusting, 23
  changing view with, 49
  flying with, 22–23
mouse pointer, 3, 22
Mouse Preferences dialog box, 23
Movies. *See* videos
MS-DOS, 169
music
  as accompaniment, 5
  selecting, in Sound Preferences dialog box, 106
  for videos, 196
My Situations filter, 133

N

naming
  photos, 174
  situations, 90, 134, 135, 149
NASA (National Aeronautics and Space Administration), 2
nebulas, described, 108
Neptune
  discovery of, 52
  zooming in on, 52–54
Newtonian mechanics, 14, 32–33, 92
numeric keypad, 4

O

observatory
  choosing location of, 210–11
  described, 209
  instrument panel, 212–13
  viewing Mars from Phobos, 209–13
Observatory Situations filter, 133
Octans, 215
Omega Centauri, 108
Open Situation dialog box, 3, 84, 132–33
Options menu, 3. *See also names of commands on this menu*
orbital distance, 53, 112
orbital inclination, 158
orbital mechanics
  apogee and perigee, 207–9
orbital mechanics, *continued*
  programming of, 147
Orbital Radius dialog box, 158
Orbit autopilot action, 153, 156, 158, 159
ORBITCOR situation, 224
orbits
  adjusting, with retroburns, 208–9
  changing, with autopilot action, 153, 158, 159
  circularizing, 208
  default distance/altitude, 53, 112, 158
  elongating, 208
  inclination of, 158
  monitoring, in Map view, 207–8
  of Saturn's moons, 4
  slowing spacecraft velocity, 208–9
  and time scale, 94
Orient autopilot action, 153, 156, 157, 170
origin, map, 69–70, 230
Orion, 6, 108, 213

P

Paige, David, 166
Paintbrush program, displaying photos in, 182–83
Pallas asteroid, 124
PANEL situation, 218
panning
  in Chase view, 56
  defined, 48, 61
  methods, 49–51
  vs. tracking, 61–63
  used in docking, 81
  used with HUD, 112
  used with observatory, 212
panning bar arrows, 47, 48, 49
panning bars, 47, 48, 49. *See also* panning
  centering, 48, 112
  location tabs, 47, 48, 112
PATROL5 situation, 218
pausing, 31, 185, 186, 187
.PCX files, 174, 182
perigee
  defined, 207
  monitoring readouts, 208
  and retroburns, 209

perspective, chase craft, 56–57, 179
Pettibone, Roger, 204–5, 220
Phobos (moon)
  described, 109
  flying to Deimos from, 112–15
  viewing Mars from observatory on, 209–13
photos, space
  chase craft perspective for, 179
  displaying, in Microsoft Windows, 182–83
  framing, 176
  hints for taking, 175–80
  and lighting, 177
  naming, 174
  saving, 174–75
  setting up, 175
  shading in, 178
  as Windows wallpaper, 182–83
Pink Floyd (*Dark Side of the Moon*), 5
Pitch Control Keys setting, 104
pitching
  defined, 17–18
  in Flight Simulator, 104
  with joystick, 17, 24
  with keyboard, 15, 17–18, 19, 104
  and photos, 180
planetarium, observatory as, 214–15
planets. *See also names of specific planets*
  atmospheres of, 204
  changing visibility of, 43–44
  described, 109
  as destinations, 109
  of distant stars, 119–22, 170
  of Polaris, 120–21
  undiscovered, 119, 122
Planets command, 53, 61, 109
playing back videos, 185, 186, 195
Pleiades, 108
.PLN filename extension, 169
Pluto, 52, 116, 118
Polaris
  constellations around, 215
  planets of, 120–21
power panning, 50. *See also* panning
Practice skill level, 79, 106, 201
Precision Preferences dialog box, 94–95
Preferences command, 23, 25, 70, 93–106
Principia (Newton), 32
Product Situations filter, 133
Prograde autopilot action, 153, 156, 157, 205
programming
  in assembly language, 58
  atmospheric effects, 202
protoplanetary disks, 213
Proxima Centauri, 41
Ptolemy, Claudius, 230

Q

Quintus Ennius, 6

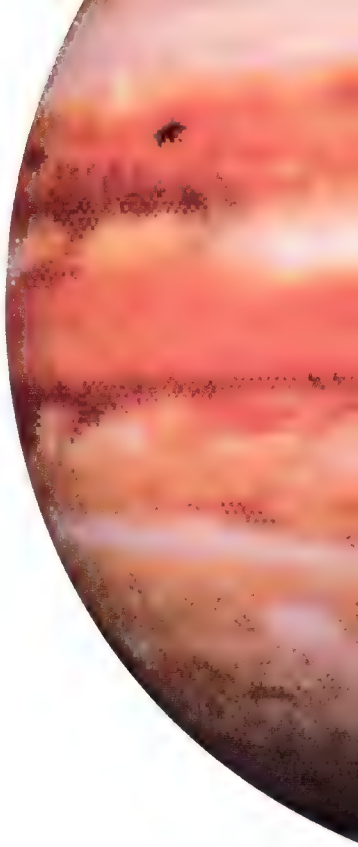
R

radial velocity, 13, 14, 34–35. *See also* velocity
radius, 53, 112, 201, 202
Ram-Jet, Bussard, 138, 139, 224
real-time flight plans, 170
recentering panning bars, 48, 112
recording videos. *See* videos
REENTRY situation, 204–5
reference display, 31, 42, 113
reference objects
  and HUD, 112
  selecting, 31, 33, 77, 84, 116
  updating, 111, 125
relative chase craft perspective, 56–57, 179
Rendering Preferences dialog box
  Ambient Light settings, 99
  Detail settings, 90, 99, 178
  Shading settings, 90, 98–99, 100, 178
Rendezvous autopilot action, 154, 156, 160
Reset button, 47, 48, 66
Reset Situation command, 133, 146
resolution, screen, 185, 187
Restore button. *See* Maximize/Restore button

Retract Lander command, 77. *See also* All Terrain Lander (ATL)
retroburns, defined, 208–9
Retrograde autopilot action, 153, 156, 209
Rigel, visiting planets of, 170
right ascension, 212
Ring Station 1
  circling, without slew control, 32–33
  circling, with slew control, 31
  docking with, 79–82, 217
  exploring cargo bay, 89–90, 91
  flying, to Alpha Centauri, 167–69
  flying ATL close to, 77–79
  flying around, 19
  flying between rings of, 20
  flying MMU to, 83–85
  rotating, 19
  spacewalking outside, 5
  "threading the needle," 216–17
  viewing, during flyby, 50–51
rolling
  defined, 17–18
  with joystick, 24
  with keyboard, 15, 17–18, 19
  and photos, 180
rotation controls
  operating, with joystick, 24
  operating, with keyboard, 15–18, 19
  operating, with mouse, 22
rotation gauge, 15–16, 17, 18

S

Sagan, Carl, 100
Sagittarius, 6, 151
Saturn, 3
  changing view of, 4
  described, 3–4, 173
  flying ATL across rings of, 171, 173
  map display of, 3, 4
  moons of, 3, 4, 220–21
Save Flight Plan dialog box, 163
Save Situation dialog box, 84, 90, 91, 134–35
saving situations, 84, 129–31, 134–35, 149
Scenery Preferences dialog box, 96–98
screen. *See also* Window menu
  designing view layout, 63–64
  resolution, for recording videos, 185, 187
  showing/hiding elements, 47, 63–66
scrolling through a list, 3
Select Assigned View Location dialog box, 59
Select Base Object dialog box, 123–24
Select Destination Object dialog box, 156–57
selecting from a list, 3
Select Map Origin Object dialog box, 69–70
Select Reference Object dialog box, 31, 77
Select Target Object dialog box, 211
Select Tracking Object dialog box, 57, 61
servo actions, defined, 155
Set Location dialog box, 123–25, 126, 204–5
Set Observatory Location dialog box, 210–11
shading
  for photos, 178
  preference settings, 98–99, 100
Shepard, Alan B., Jr., 7
Show filters, in Open Situation dialog box, 133
Show/Hide Head-Up Display commands, 66, 112, 113
Show/Hide Instrument Panel commands, 66
Show/Hide Map View commands, 66
Show/Hide View commands, 49, 66
Show/Hide View Tools commands, 47, 66
Show/Hide Window Titles commands, 66
shuttle. *See* space shuttle
Shuttle Landing Facility, 204. *See also* Cape Canaveral
Simulation Error message box, 221
Simulation Precision scale, 94
simulations, programming, 92
situations
  building on, 138–39
  creating, 136
  deleting, 133



situations, *continued*
describing, 132, 134–35
filters for, 133
naming, 90, 134, 135, 139
opening, 132–33, 140
resetting, 133, 146
saving, 84, 129–31, 134–35, 149
startup, 133, 139
updating, 90, 135
Skill Level Preferences dialog box, 79, 106, 201
skill levels, 79, 106
slew control
changing velocity in, 36
controlling gravity in, 38, 39
controlling velocity in, 34–35
defined, 28
and fine thrust, 85–87
vs. flight control, 31–33
flying with, 33–39
keys for, 29
reversing thrust in, 36–37
and time scale, 85, 177
turning on and off, 28, 31, 32
Slew Control command, 28, 31
slewing telescopes, 212
SMARTDrive, 195
Smooth shading option, 98–99, 100, 178
solar system
exploring another, 119–22, 226–27
mother star, 170
touring our own, 163–66
Solon, Jon, 6, 39, 82, 136, 199
exploring cargo bay, 91
flying with joystick, 26
and FORCHRIS situation, 129–30
on pitch control keys, 104
and Set Location command, 125
Sound Preferences dialog box, 106
spacecraft. *See also names of specific spacecraft*
morphing, 226
refueling, 60, 227
Spacecraft command (Flight menu), 60, 110
Spacecraft command (Location menu), 110, 112, 226
space shuttle
atmospheric entries with, 201
launching, with flight computer, 160, 161
Space Simulator
early releases, 26, 31, 96, 100
exiting, 182
programming of, 58, 92, 147, 202
Star-Pilot's Guide, 14
starting, 9, 133, 139
Space Station Freedom
flying MMU close to, 73–75
inspecting solar panels, 218
reaching, 218
space stations. *See also names of specific space stations*
on Location menu, 110
rotating to simulate gravity, 19
spacewalking outside, 5
as tracking objects, 144–45, 146
Space Stations command, 37, 59, 110
Space Walk autopilot action, 153, 154
Space Walk command, 74, 112
spacewalking, 5, 74, 112, 115, 154
Sparse detail option, 99
speed. *See* frame rate; velocity
speed of light, 40, 41
Sperry, Tom, 221
star clusters, defined, 108
Star Limiting Magnitude scale, 98
Star-Pilot's Guide, 14
stars
Alpha Centauri, 40–42, 167–69
atmospheres of, 202
Betelgeuse, 41, 109
defined, 108–9
limiting magnitude, 98
planetary systems of, 119–22
Proxima Centauri, 41
Stars command, 38, 108–9
startup situation, 133, 139
Sun
described, 109
gravitational pull of, 38–39

sunlight. *See* light
Surface command, 110

T

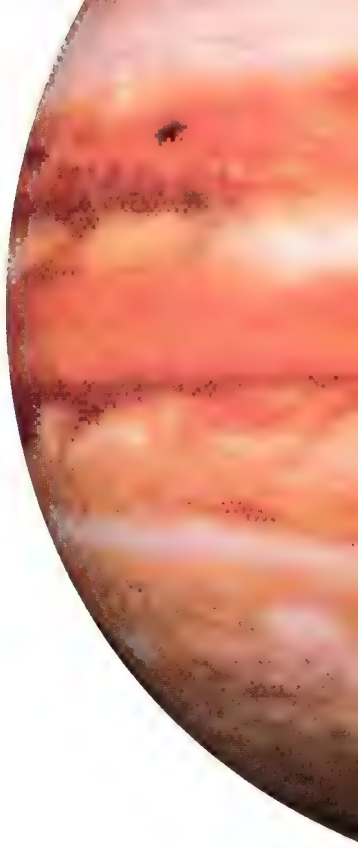
tangential velocity, 13, 14, 34–35, 208. *See also* velocity
target object, for observatory, 211
Taurus-Littrow, 110
telescopes
  Alt/Azi measurement, 212
  clock drive, 213
  early, 35, 173
  Hubble, 122, 213
  panning vs. tracking, 212
  RA/Dec measurement, 212
  slewing, 212
temperature crashes, 201
Tennyson, Alfred Lord, 39
thrust. *See also* acceleration; fine thrust
  decreasing, 13, 14, 135
  defined, 34
  gauge, 13, 14, 34
  increasing, 13, 35
  and Newtonian mechanics, 32, 33, 34, 35
  reversing, in slew control, 36–37
Thrust autopilot action, 154, 159, 160, 170
thrust gauge, 13, 14, 34
time, Universal, 113
Time dialog box, 43–44, 113, 211, 216
time scale
  adjusting, for Andromeda mission, 116, 118
  adjusting, in slew control, 85, 177
  and autopilot, 160, 170
  changing, 41–44, 177
  defined, 40
  and imagining the future, 44
  and lighting, 43, 177
  maximum rate, 41, 118
  and retaining orbits, 94
  and velocity, 42
  in videos, 187
title bar, 47, 49, 66
toggles, 28, 66
tracking
  defined, 61
  Earth flyby using, 62–63
  for executing flight plans, 165
  for observatory, 211
  vs. panning, 61–63
  for viewing docking, 81
tracking objects
  in BUSYSKY, 150
  and Chase view, 144–45, 146
  selecting, 57, 61
  space stations as, 144–45, 146
  updating, 57, 111, 125, 150
  using, 91, 144–45
transferring control. *See* Vehicle Transfer command
TRIP1 flight plan, 164–65, 166, 167
true velocity, 35. *See also* velocity
Turnover autopilot action, 153, 157, 170
2001: A Space Odyssey, 152, 183

U

undiscovered planets, 119, 122
Undock autopilot action, 154
Undock command, 81
Universal time, 113
updating
  situations, 90, 135
  tracking object, 57, 111, 125, 150
upper atmosphere, 201

V

Valles Marineris, 143
Vehicle Transfer autopilot action, 153, 154
Vehicle Transfer command, 110, 112, 149, 226
Veil nebula, 6
velocity
  for atmospheric entries, 201
  changing, in slew control, 36, 86
  combined, 35
  controlling, in flight control, 35, 84–85



velocity, *continued*
controlling, in slew control, 34–35, 85–86
cutting, 36
defined, 34
maximizing, 36
and Newtonian mechanics, 32, 33, 34–35
as percentage of speed of light, 35
radial, 13, 14, 34–35
tangential, 13, 14, 34–35, 208
true, 35
velocity readouts, 13, 14, 34–35
Venus, 141, 160, 202
vertical panning bar, 47, 48. *See also* panning; panning bars
Video Recorder dialog box, 183–86
videos
deleting, 185
and disk caching, 195
editing, 187
Looping Playback feature, 185, 195
making practice recordings, 195
about Mars Base Marineris, 189–95
pausing, 185, 186, 187
playing back, 185, 186, 195
screen resolution, 185, 187
shortcut keys, 186
soundtracks for, 196
starting recording, 184–85
stopping recording, 185
storage space for, 183, 184–85
time scale in, 187
View Controls dialog box, 55, 61, 66–71, 91
View Controls For Map View dialog box, 69
View Direction button. *See* Direction button
viewing methods. *See* panning; tracking
View Location button. *See* Location button
views
Assigned, 58, 59–60, 67, 68–69
Chase, 16, 20, 54–58, 68
Cockpit, 16, 47–51, 57–58, 112, 113
cycling through, 16, 54, 57–58, 59
view tools, displaying, 47, 66. *See also names of specific tools*
view windows
arranging, 63–66
closing, 49, 65
customizing, 66–71
maximizing, 49
showing/hiding, 64, 65, 66
Virgo constellation, 122
Voyager 2, 52, 229–30

W

Wagner, Richard ("Ride of the Valkyries"), 136
wallpaper, space photos as, 174, 182–83
Welles, Orson, 194
Wells, H. G., 194
Whirlpool galaxy, 111
Wilkinson, Patrick, 22, 125, 136
Window menu, 63–71. *See also names of commands on this menu*
windows. *See also* view tools; view windows; Window menu
designing view layout, 63–64
showing/hiding screen elements, 63–66
Windows environment. *See* Microsoft Windows, displaying photos in
Wolszczan, Alexander, 122
wraparound view, 47, 48–50

Y

yawing
defined, 15, 16–17
with joystick, 24
with keyboard, 15, 16–17, 19
and photos, 180
yoke mode, 22

Z

Zander Freighter
described, 128, 224
docking, with Lunar Orbiter, 218
flying to Cybele with, 126, 128
Zoom buttons, 47, 51–52, 66
zooming
changing zoom factor, 52, 53, 55
standard setting, 52

About the Author

Grant Fjermedal is a Seattle-based writer who likes real-world adventures such as sailing and cheering his nephews through soccer games and who also enjoys virtual-world adventures such as flying great ships through space. He is a former writer for the *Seattle Times* and the Associated Press; his work has also appeared in the *New York Times* and *Omni*. His second book, *The Tomorrow Makers*, which explored the wild frontiers of robotics and artificial intelligence, was named by the American Library Association as one of the 10 best nonfiction books published in 1987. His third book, *New Horizons in Amateur Astronomy*, chronicled the adventures of comet hunters, nova patrollers, and other passionate observers of the sky.

Grant is interested in hearing about your adventures and discoveries within Space Simulator. He can be contacted electronically over CompuServe at 75152,303 or the old-fashioned way at P.O. Box 31091, Seattle, Washington 98103.

About the Book

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This book is illustrated both with screen captures from Space Simulator and with the following photographs and art:

Title page: View of Earth, taken by the Galileo spacecraft, 1992; courtesy of NASA/Jet Propulsion Laboratory. **Page 1:** Synthetic perspective view of the volcanoes Sapas Mons and Maat Mons on Venus; courtesy of NASA/Jet Propulsion Laboratory. **Page 2:** Apollo 11 lift-off, 1969; courtesy of NASA. **Page 8:** The planet Earth; courtesy of NASA. **Pages 12–13:** Synthetic perspective view of Ishtar Terra on Venus; courtesy of NASA. **Page 18:** Photo courtesy of Jeff Welsh. **Page 27:** Jupiter, as imaged by Voyager 1; courtesy of NASA/Jet Propulsion Laboratory. **Page 38:** Solar flare, photographed by the Skylab mission, 1973; courtesy of NASA. **Pages 40–41:** Apollo 11 lift-off and lunar landing, 1969; courtesy of NASA. All other timeline photos courtesy of Robert Welsh. **Page 45:** Composite photo of Mars, taken by the Viking spacecraft; courtesy of NASA. **Pages 46–47:** Artist's conception of spherical halo of neutrinos around the Milky Way galaxy; courtesy of NASA. **Pages 58–59, 60–61:** Composite photo of Mars, taken by the Viking spacecraft; courtesy of NASA. **Page 72:** Detail from North Celestial Planisphere by Thomas Hood, c. 1590; by permission of the British Library, London. **Page 73:** Image of the Earth's Moon taken by the Galileo spacecraft, 1992; courtesy of NASA/Jet Propulsion Laboratory. **Pages 82–83:** Synthetic perspective view of the volcanoes Gula Mons and Sif Mons on Venus, from a combination of Magellan synthetic aperture radar data and radar altimetry; courtesy of NASA/Jet Propulsion Laboratory. **Page 87:** View of Earth, taken by the Galileo spacecraft, 1992; courtesy of NASA/Jet Propulsion Laboratory. **Page 93:** Composite photo of Mars, taken by the Viking spacecraft; courtesy of NASA. **Pages 100–101:** View of Earth; courtesy of NASA. **Page 107:** Image of Saturn, captured by Voyager 2, 1981; courtesy of NASA/Jet Propulsion Laboratory. **Page 119:** Infrared map of the Swan nebula, made with data obtained from the Kuiper Airborne Observatory; courtesy of NASA. **Page 127:** The asteroid Gaspra, photographed by the Galileo spacecraft; courtesy of NASA/Jet Propulsion Laboratory. **Page 129:** Synthetic perspective view of the volcano Maat Mons on Venus, based on images taken by the Soviet Venera 13 and 14 landers; courtesy of NASA. **Pages 142–43:** Simulation of an approaching dust storm on the surface of Mars. **Page 151:** Time-lapse exposure of the Milky Way galaxy, with the trail of the Echo I communications satellite in the foreground, 1978; courtesy of NASA. **Pages 152–53:** Magellan spacecraft in low Venus orbit; courtesy of NASA. **Pages 166–67:** View of Mercury; courtesy of NASA. **Page 171:** View of Mars, taken by the Viking spacecraft, 1980; courtesy of NASA. **Pages 188–89:** Composite photo of Mars, taken by the Viking spacecraft; courtesy of NASA. **Page 197:** False-color image of Earth's Moon, taken by the Galileo spacecraft, 1992; courtesy of NASA/Jet Propulsion Laboratory.

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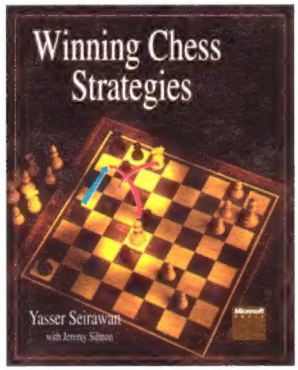
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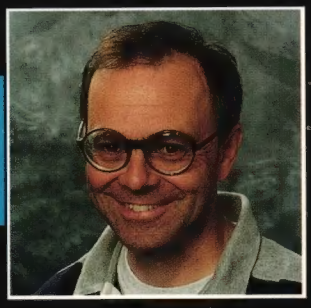
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